ICOM COMMITTEE FOR CONSERVATION

5th Triennial Meeting

Zagreb, 1-8 October 1978

PREPRINTS

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Brief History of the Committee for Conservation

The Committee for Conservation has its origins in a Commission for the Care of Paintings that was established in 1948, the second year following the founding of the International Council of Museums (ICOM). The aim of this Commission, which was composed of museum directors and curators, was to gather information on all aspects of the examination, recording, cleaning and repair of paintings. Some of the distinguished reviews that resulted from the work of the commissions were published in Museum [for example, "The Care of Wood Panels", Vol. 8, No. 3, 138-194 (1955); "Fabric Paint Supports", Vol. 13, No. 3, 134-171 (1960); and "Grounds in Painting", Vol. 21, No. 4, 245-276 (1968)].

With the growth of interests in technical examination of artifacts and conservation practices, evidenced by the formation of the International Institute for the Conservation of Historic and Artistic Works in 1950, an international subject committee on Museum Laboratories was established by ICOM in 1951, and this committee began to hold meetings jointly with the Commission on the Care of Paintings every two years from 1955 to 1967. In the latter year, at a meeting in Bruxelles, it was decided to consolidate these two activities into one group - the Committee for Conservation. Moreover, at the second meeting of the Committee for Conservation, held in Amsterdam in 1969, it was considered advisable to hold meetings of the full committee only every three years and hence the third meeting was held in Madrid in 1972, the fourth in Venice in 1975. In years when the full Committee was not scheduled to meet, the Directory Board has encouraged colleagues concerned with the activities of various working parties to hold smaller meetings devoted to special topics.

A brief record of this history, the dates and places of meetings held, and the citation of reports describing them, appears in the introduction to a supplement to Art and Archeological Technical Abstracts, Vol. 14, No. 2, 1977, pp. 372-477, prepared by Dr. John Winter of the Freer Gallery of Art, Washington, D.C. Dr. Winter's outstanding contributions, entitled "ICOM Reports on Technical Studies and Conservation", provides 295 abstracts of reports that have been submitted to the ICOM Committee over the years. The Directory Board is most grateful of the efforts of Dr. Winter and his colleagues at the Freer Gallery of Art for this great service, the most complete record of the activities of the Committee for Conservation that has been prepared. As usual, copies of the reports can be obtained from the Librarian at the International Centre for Conservation, 13 Via di San Michele, 00153 Rome, Italy, at a cost of 60 Italian Lira per page (plus postage) and also from the UNESCO-ICOM Documentation Centre, 1 rue Miollis, 75015 Paris, France.

The size of this handsome set of reports, accepted by the coordinators of the more than twenty working groups for the 1978 meeting, and the equally fine collection of reports published in 1975, attest to the international significance of the triennial meetings of the Committee for Conservation. It is clear from these reports that a concerted effort is being made by the coordinators and the directory board to fulfill the objectives stated in the accompanying description of the committee and its working rules. The Committee plays a vital role internationally by encouraging these triennial sessions that serve to sum up the progress in the field of conservation, the latest knowledge in special areas of concern and the current "state of the art" concerning methods and procedures. The tradition of maintaining an interchange of information and views with museum directors and curators is reflected in the requirement that persons of such training, experience, and present duties must be represented among the elected members of the directory board. Hopefully, this interchange, which was strongly encouraged at the time when meetings between the Commission on the Care of Paintings and the Committee on Museum Laboratories were jointly held, may be strengthened in the future, for it is of the greatest importance that the objectives and methods of conservation specialists be understood by those with administrative and curatorial responsibilities in museums and, in a similar sense, it is important that the conservator, the conservator-scientist, and the pure scientists contributing to our field understand the problems and objectives of the curatorial profession. Therefore, it is hoped in the future that, as well as continuing to coordinate and review activities in the world of conservation, the ICOM Committee for Conservation can serve to encourage and advance the mutual understanding of conservation problems and objectives between all members of the museum community.

R. L. Feller
President

ICOM Committee for Conservation

Comité pour la conservation de l'ICOM

Directory Board 1975-1978

Conseil de direction 1975-1978

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Congress Secretariat	Secrétariat de la réunion
Monique Berends-Albert	The Netherlands/Pays-Bas
Barbara Berlowicz	Denmark/Danemark
Henrik Bjerre	Denmark/Danemark
Silvije Novak	Yugoslavia/Yougoslavie
Dubravka Penavič	Yugoslavia/Yougoslavie
Puccio Speroni	Italy/Italie
Vinko Štrkalj	Yugoslavia/Yougoslavie
Hrvoje Malinar	Yugoslavia/Yougoslavie

Participants in the meetings of the ICOM Committee for Conservation are personally invited not as representatives of their country or Institution but as specialists in their field.

Les participants aux réunions du Comité pour la conservation de l'ICOM sont invités personnellement à titre de spécialiste; ils ne représentent ni leur pays ni leur institution.

Working Group and Coordinator 1975-1978

Groupe de travail et Coordinateur 1975-1978

1. New Applications of Methods of Examination/
   Nouvelles applications de méthodes d'examen

   - H.C. von Imhoff, Coordinator
     Musée d'Art et d'Histoire
     Rue Pierre-Aeby 227
     CH-1700 Fribourg, Switzerland/Suisse

   - Ch. Lahanier, Assistant coordinator
     Laboratoire de Recherches des Musées de France
     Palais du Louvre (Pavillon Flore)
     Paris 1, France

2. Structural Restoration of Easel Paintings/
   Restauration structurale de peintures sur toile

   - W.W. Percival-Prescott, Coordinator
     National Maritime Museum Greenwich
     London SE 10 9 NF, U.K./Royaume Uni

   - P. Boissonnas
     Baschligplatz 1
     8032 Zürich, Switzerland/Suisse

3. Ethnographic Materials/Matériaux ethnographiques

   - W.P. Bauer, Coordinator
     Museum für Völkerkunde
     Neue Hofburg
     1014 Vienna, Austria/Autriche

   - H.V. Gowers
     Ethnographic Department
     The British Museum
     6 Burlington Gardens
     London W1X 2EX, U.K./Royaume Uni

4. Documentation/Documentation

   - Y. Grenberg, Coordinator
     Ministry of Culture SSSR
     WCNILKR
     10, Krestyanskaya Sq.
     Moscow, USSR/URSS

   - H. Barker, Assistant coordinator
     The British Museum
     Research Laboratory
     39 Russell Square
     London WC1B 3DG, U.K./Royaume Uni

5. Polychromed Sculpture/Sculpture polychrome

   - P. Philippot, Coordinator
     178 Avenue Chr. Michiels
     Boîte 17
     Brussels 1170, Belgium/Bruxelles 1170, Belgique

   - A. Ballestrem, Assistant coordinator
     Landeskonservator Rheinland
     Bachstrasze 9
     53 Bonn, Fed.Rep. of Germany/Rép. Féd. d'Allemagne

6. 20th Century Paintings/Peintures du 20ème siècle

   - P. Cadorin, Coordinator
     Kunstmuseum
     St. Albangraben 16
     CH-4051 Basel, Switzerland/Suisse

7. Conservation of Waterlogged Wood/Bois gorgés d'eau

   - R. Munnikendam, Coordinator
     Centraal Laboratorium voor Onderzoek van Voorwerpen
     van Kunst en Wetenschap
     Gabriël Metsustraat 8
     Amsterdam, The Netherlands/Pays-Bas

8. Reference Materials/Matériaux de référence

   - J. Winter, Coordinator
     Freer Gallery of Art
     Smithsonian Institution
     Washington D.C. 20560, USA/Etats-Unis

9. Textiles/Textiles

   - J.H. Hofenk-de Graaff, Coordinator
     Centraal Laboratorium voor Onderzoek van Voorwerpen
     van Kunst en Wetenschap
     Gabriël Metsustraat 16
     Amsterdam, The Netherlands/Pays-Bas

   - M. Flury-Lemberg, Assistant coordinator
     Abegg-Stiftung Bern
     CH 3132 Riggisberg, Switzerland/Suisse

10. Stone/Matériaux pierreux

   - J. Lehmann, Coordinator
     Muzeum Narodowe
     Al. Marcinkowskiego 9
     61-745 Poznan, Poland/Pologne

   - J. Riederer, Assistant coordinator
     Staatliche Museen Preussischer Kulturbesitz
     Rathgen-Forschungslabor
     D 1000 Berlin 30, Fed. Rep. of Germ./Rép. Féd. d'All.

11. History and Theory of Restoration/Théorie et histoire de la restauration

- H. Althöfer, Coordinator
  Restaurierungszentrum der Landeshauptstadt Düsseldorf
  Ehrenhof 5
  4 Düsseldorf-Nord, Fed. Rep. of Germ./Rép.Féd.d'All.

- I.P. Gorine, Assistant coordinator
  WCNILKR
  10 Krestyanskaya Sq.
  Moscow, USSR/URSS

12. Care of Works of Art in Transit/Protection des oeuvres d'art pendant le transport

- N. Stolow, Coordinator
  Special adviser (Conservation)
  National Museums of Canada
  L'Esplanade Laurier 22nd Floor
  Ottawa K1A OM8, Canada

13. Natural History Collections/Collections d'histoire naturelle

- G. Meurgues, Coordinator
  Muséum National d'Histoire Naturelle
  Service National de Muséologie
  Laboratoire de Naturalisation
  36, Rue Géoffroy-Saint-Hilaire
  Paris V, France

14. Graphic Documents and Illuminated Manuscripts/Documents graphiques et enluminures

- F. Flieder, Coordinator
  Centre de Recherches sur la Conservation des Documents Graphiques
  Muséum National d'Histoire Naturelle
  36, Rue Géoffroy-Saint-Hilaire
  Paris V, France

15. Mural Paintings and Mosaics/Peintures murales et mosaïques

- P. Mora, Coordinator
  Istituto Centrale del Restauro
  9 Piazza S. Francesco di Paola
  Rome 00184, Italy/Italie

- L. Sbordoni Mora, Assistant coordinator
  Via Appia Antica 228
  Rome, Italy/Italie

16. Protective Coatings, Traditional and Modern/
Couches protectrices, traditionnelles et modernes

- R.L. Feller, Coordinator
Carnegie Mellon Institute
4400 Fifth Avenue
Pittsburgh, Penn. 15213, USA/Etats-Unis

- E. de Witte, Assistant coordinator
Institut Royal du Patrimoine Artistique
1 Parc du Cinquantenaire
1040 Brussels, Belgium/1040 Bruxelles, Belgique

17. Nuclear Applications to Conservation/Applications nucléaires à la conservation

- Chr. de Tassigny, Coordinator
Centre d'Etudes Nucléaires de Grenoble
Département des Radioéléments
Cedex no. 85
38 Grenoble Gare, France

- R. Ramière, Assistant coordinator
CENG Grenoble Sarr
B.P. no. 85 Centre de Tri
38041 Grenoble Cedex, France

18. Lighting and Air Conditioning/Eclairage et conditionnement de l'air

- G. Thomson, Coordinator
Scientific Department
The National Gallery
Trafalgar Square
London WC2N 5DN, U.K./Royaume Uni

19. Conservation of Leathercraft and Related Objects/
Conservation des cuirs artisanaux et objets similaires

- T. Stambolov, Coordinator
Centraal Laboratorium voor Onderzoek van Voorwerpen van Kunst en Wetenschap
Gabriël Metsustraat 8
Amsterdam, The Netherlands/Pays-Bas

20. Easel Paintings/Peintures de chevalet

- H. Kühn, Coordinator
Deutsches Museum
8 München 26, Fed. Rep. of Germ./Rép.Féd. d 'Allem.

21. Silicious Archaeological Materials/Matériaux siliceux archéologiques

    - L. Vlad Borrelli, Coordinator
      Via XXIV Maggio 51
      Rome, Italy/Italie

22. Training of Restorers/Formation des restaurateurs

    - K.E. Holm
      Nationalmuseet
      Brede
      2800 Lyngby, Denmark/Danemark

    - P. Cannon-Brookes, Assistant coordinator
      National Museum of Wales
      Cardiff CF1 3NP, U.K./Royaume Uni

23. Metals/Métaux

    - R.M. Organ, Coordinator
      Conservation-Analytical Laboratory
      Smithsonian Institution
      Washington D.C. 20560, USA/Etats-Unis

VIII

Composition and working rules for the ICOM Committee for Conservation

1. The Committee and its aims

1.1 *The ICOM Committee for Conservation* is a permanent committee of the International Council of Museums.

Among its aims are:

a. The achievement and maintenance of the highest standards of conservation and examination of historic works by bringing together from all countries those who are responsable for cultural property: restorers, research workers and curators.

b. to promote researches of a scientific or technological nature pertaining thereto.

c. to collect data and information about materials and workshop methods.

d. to make generally available by publication or otherwise the esults of such enquiries.

1.2 *The ICOM Committee for Conservation* is composed of the *Directory Board* and *Working Groups* with their *Coordinators*. The members of the Directory Board and the Coordinators must be members of ICOM or must undertake to become members within three months of appointment; membership is not considered to be an essential requirement in other cases.

2. Directory Board

2.1 The Directory Board (hereinafter called the Board) is composed of eight members elected for three years by the Committee and one ex-officio member, namely the Director of the Rome Centre. Members are eligible for reelection.

2.2 The board elects its Chairman from among the elected members and appoints an Administrative Secretary and a Secretary for Publications.

2.3 Among the elected members of the Board, who may also be Coordinators, should be represented Museum Curators, Restorers and Museum Scientists.

2.4 Delegates from international organizations such as UNESCO, IIC, and ICOMOS will normally be invited to attend meetings of the Board as observers.

2.5 The Board will endeavour to meet at least once every year.

2.6 The functions of the Board are the following:

a. to appoint Coordinators for definite tasks and for fixed periods of time.

b. to establish with Coordinators the programme of the Committee for Conservation.

c. to control the progress of work.

3. Coordinators

3.1 Coordinators will hold their offices at the discretion of the Board.

3.2 The Coordinator will choose the members of his Working Group in consultation with and with the approval of the Board and will direct its activities.

3.3 With the approval of the Board the Coordinator may organize joint meetings of specialists in his field, visits to laboratories, sites, etc., having a direct bearing on the progress of his investigation.

3.4 Each Coordinator will submit, annually, to the Secretariat of the Committee for Conservation and not later than 3 weeks before the meeting of the Board, a report on the progress of the work of his group.

4. Working Group Members

4.1 On a proposal from the Coordinator, and with the approval of the Board, members will be assimilated in a group and be allocated a particular subject to study.

5. Procedure and Finance

5.1 The Committee for Conservation meets normally every 3 years in full session to hear reports on the progress of the work being carried out by the working groups under their Coordinator, to propose future programmes to the Board, and to encourage contact between the members of the working groups.
All interested persons may attend meetings with the approval of the Chairman of the Board.

5.2 While Groups meet by arrangement at times found to be most expedient, the Board will endeavour to meet annually.

5.3 Manuscripts prepared by Working Groups which are ready for publication shall be passed to the Secretary for Publications for submission to the International Coordination Committee for Publications.

5.4 The Committee's budget will be submitted for approval every 3 years to the full session of the Committee.

6. Amendments

The Directory Board will have the power to make provisional changes in the composition and working rules to be presented for ratification at the next meeting of the Committee.

Statuts du Comité de l'ICOM pour la Conservation

1. Le comité et ses buts

1.1 *Le Comité de l'ICOM pour la Conservation* est un comité permanent du Conseil International des Musées.
Ses buts sont entre autres :

a. d'atteindre et de maintenir le plus haut niveau de la conservation et de l'examen des oeuvres d'art en mettant en contact ceux qui - dans tous les pays - sont responsables pour les biens culturels : restaurateurs, chercheurs scientifiques et conservateurs.

b. de promouvoir des études scientifiques ou technologiques rélatives à cet objectif.

c. de réunir des données et des information sur les matériaux et les méthodes d'atelier.

d. de diffuser les résultats de telles enquêtes par des publications ou autrement.

1.2 *Le Comité de l'ICOM pour la Conservation* est composé d'un *Conseil de Direction* et de *Groupes de Travail* avec leurs *Coordinateurs*.
Les membres du Conseil de Direction et les Coordinateurs doivent etre members de l'ICOM ou le devenir dans les trois mois après leur nomination. Dans les autres cas il n'est pas consideré essentiel d'être membre de l'ICOM.

2. Le Conseil de Direction

2.1 Le Çonseil de Direction (nomme le Conseil ci-dessous) est composé de huit membres élus pour trois ans par le Comité et du Directeur du Centre de Rome, qui en fait partie ex officio. Les membres peuvent etre réelus.

2.2 Le Conseil choisit son Président parmi les membres élus et nomme un Secrétaire Administratif et un Secrétaire aux Publications.

2.3 Parmi les membres élus du Conseil, qui peuvent être également des Coordinateurs, les conservateurs de musée, les restaurateurs et les spécialistes de laboratoire de musée doivent être représentés.

2.4 Des représentants des organisations internationales comme l'UNESCO, l'IIC et l'ICOMOS seront généralement invités à assister aux réunions du conseil à titre d'observateur.

2.5 Le Conseil essayera de se réunir au moins une fois par an.

2.6 Les fonctions du Conseil sont les suivantes :

a. de nommer les coordinateurs pour des tâches bien déterminées et pour des périodes fixées.

b. d'établir le programme du Comité pour la Conservation en accord avec les Coordinateurs.

c. de contrôler le progrès des travaux.

3. Coordinateurs

3.1 Les Coordinateurs garderont leurs fonctions sous l'approbation du Conseil.

3.2 Le Coordinateur choisit les membres de son Groupe de Travail en consultation et avec l'approbation du Conseil et en dirige les activités.

3.3 Le Coordinateur peut organiser avec l'agrément du Conseil des réunions de specialistes dans la matière de son ressort, des visites aux laboratoires, sites, etc. directement liées au progrès de son travail.

3.4 Chaque année et trois semaines avant la réunion du Conseil au plus tard le Coordinateur envoie au Secrétariat du Comité pour la Conservation un rapport sur l'état d'avancement du travail de son groupe.

4. Les membres des Groupes de Travail

4.1 Sur la proposition du Coordinateur et avec l'approbation du Conseil, des membres seront assimilés dans un groupe pour l'étude d'un sujet déterminé.

5. Fonctionnement et Finances

5.1 Le Comité pour la Conservation se réunit normalement tous les trois ans en séance plénière pour entendre les rapports sur le progrès du travail exécuté par les Groupes de Travail sous la direction du Coordinateur, afin de proposer les programme futurs au Conseil et pour encourager les contacts entre les membres des Groupes de Travail.
Toutes les personnes intéressées peuvent assister aux réunions du Comité avec la permission du Président du Conseil.

5.2 Les Groupes de Travail arrangent des réunions aux moments les plus propices; le Conseil tâchera de se réunir chaque année.

5.3 Les manuscrits préparés par les Groupes de Travail destinés à être publiés seront envoyés au Secrétaire aux Publications afin d'être soumis au Comité International de Coordination pour les Publications.

5.4 Tous les trois ans le budget du Comité est soumis à l'approbation du Comité en séance plenière.

6. Amendements

Le Conseil peut faire des changements provisoires dans les Statuts à presenter pour une ratification à la prochaine réunion du comité.

ICOM Committee for Conservation

By-laws for the Elections of the Directory Board

1. The election of the Directory Board by the Committee takes place every three years during the Plenary Meeting of the Committee.
2. The Directory Board is elected by those present at the Plenary Meeting who have been members of the Committee in the three preceding years.
3. All electors are eligible.
4. Members can put themselves up for election by informing the Secretariat either orally or in writing of their candidacy not later than 24 hours before the election. No candidates can be accepted after this dead-line. Candidates should mention to the Secretariat whether they consider themselves a curator, restorer or scientist.
5. It is not necessary for a candidate to support his candidacy with signatures of members. A provisional list of candidates containing at least sixteen names in alphabetical order is prepared by the Directory Board.
6. The Secretariat prepares a voting-ballot by arranging the candidates in three columns according to their belonging to one of the three categories: curators, restorers or scientists. Each candidate can only appear in one column. Initials and full name of the candidate should be mentioned on the voting-ballot.
7. Prior to the election the Secretariat shall distribute one voting-ballot only to each individual member. The Secretariat shall keep a record of this distribution.
8. Prior to the election a Supervisor of the election is appointed from among the members present as well as two Overseers. The Supervisor opens the voting-boxes and reads the results. These are recorded by two persons appointed by the Secretariat. The Overseers check that the votes are correctly recorded.
9. Each member shall name a maximum of eight candidates on the voting-ballot by placing a cross behind their names. Each column, corresponding with a category of curators, restorers or scientists should contain at least two crosses.
   Voting-ballots containing more than eight crosses are void.

10. Members shall put their individual voting-ballot into a previously sealed voting-box. Voting-ballots should be signed by the Supervisor before being put into the voting-box.

    Voting-ballots not carrying the signature or initials of the Supervisor are void.

11. When the time allotted for the voting is expired the voting-boxes shall be assembled and opened by the Supervisor whereupon the public counting of the votes shall proceed.

12. The number of crosses appearing after the names of a candidate is recorded. When all voting-ballots have thus been counted the numbers are added-up.

13. Are being elected first the two candidates who in each column have acquired the greatest number of votes. When two candidates in one category have obtained an equal number of votes and this number is greater than that of any other candidate in that category, they shall both be elected. When three or more candidates in one category have the same number of votes and this number is greater than that of any other candidate in that category two of them shall be assigned by lot. When two or more candidates in one category have acquired an equal number of votes and this number is smaller than that obtained by one other candidate in that category but greater than that acquired by any other candidate in that category one of these candidates shall be assigned by lot.

14. When thus the first six members of the Directory Board have been elected two further members shall be elected from among the remaining candidates i.e. the two remaining candidates from any category having acquired the greatest number of votes. When two of the remaining candidates have obtained the same number of votes greater than that of any other remaining candidate they shall both be elected. When three or more of the remaining candidates have obtained the same number of votes and this number is greater than that of the other remaining candidates two of them shall be assigned by lot. When the above situations do not occur and two or more remaining candidates have acquired the same number of votes and this number is smaller than that obtained by one other remaining candidate but greater than that obtained by all other remaining candidates, one of them shall be assigned by lot.

Assigning by lot is carried out by the Supervisor according to a procedure of his choice. When more than two candidates from the same country are elected only the two candidates having acquired the greatest number of votes or being assigned by the above described procedure are confirmed. The vacancy thus created shall be filled by applying the procedure described in articles 13 and 14.

15. The newly elected Directory Board assumes its functions from the moment that the results are read to the Plenary Meeting by the Supervisor or the Secretariat.

16. The Supervisor shall decide in matters arising during the electorial procedure for which these By-Laws do not provide.

17. Immediately after the election of the board, a chairman and vice-chairman will be elected. To this purpose the previous secretary will provide appropriate ballots and conduct the election. The person acquiring the largest number of votes will be elected chairman and the person receiving the next largest number will be vice-chairman. In case of a tie for either office a second round of voting will take place between the candidates who have tied.
In accordance to the Statutes of ICOM, no person can hold the office of chairman for more than six consecutive years.

18. As soon as possible, following the election of the chairman and vice-chairman, the secretary of the Committee shall be appointed by the board.

Comité pour la conservation de l'ICOM

Règlement pour les élections du Conseil de direction

1. L'élection du Bureau directeur par le Comité prend place chaque trois ans durant la Réunion plénière du Comité.

2. Le Bureau directeur est élu par ceux présents à la Réunion plénière qui ont été membres du Comité durant les trois précédentes années.

3. Tous les électeurs sont éligibles.

4. Les membres peuvent se présenter eux-mêmes aux élections en informant le Secrétariat, soit oralement soit par écrit, de leur candidature pas plus tard que 24 h avant l'élection. Aucun candidat ne peut être accepté après cette date limite. Les candidats mentionneront au Secrétariat qu'ils sont curateur, restaurateur ou scientifique.

5. Il n'est pas nécessaire pour un candidat de faire appuyer sa candidature par des signatures de membres. Une liste provisoire des candidats comprenant au moins seize noms dans l'ordre alphabétique est préparée par le Comité directeur.

6. Le Secrétariat prépare les bulletins de vote en répartissant les candidats en trois colonnes suivant qu'ils appartiennent à l'une des trois catégories: curateur, restaurateur ou scientifique. Chaque candidat ne peut apparaître que dans une seule colonne. Les initiales et le nom entier du candidat seront mentionnés sur le bulletin de vote.

7. Avant l'élection le Secrétariat distribuera un bulletin de vote à chaque membre individuel. Le Secrétariat teindra un registre de cette distribution.

8. Avant l'élection un Président de l'élection est nommé par les membres présents ainsi que deux Assistants. Le Président ouvre les urnes et lit les résultats. Ils sont enregistrés par deux personnes nommées par le Secrétariat. Les Assistants controlent que les votes sont correctement enregistrés.

9. Chaque membre pourra nommer au maximum huit candidats sur le bulletin de vote en plaçant une crois derrière leurs noms. Chaque colonne correspondant à une catégorie de curateurs, restaurateurs ou scientifiques contiendra pour le moins deux croix. Les bulletins contenant plus de huit croix sont nuls.

10. Les membres devront mettre leur bulletin de vote individuel dans une urne scellée auparavent. Les bulletins de vote seront signés par le Président avant d'être mis dans l'urne.

    Les bulletins de vote ne portant pas la signature ou les initiales du Président sont nuls.

11. Le temps alloué au vote terminé les urnes seront rassemblées et ouvertes par le Président; là-dessus les votes seront comptés en public.

12. Le nombre des croix apparaissant après les noms d'un candidat est enregistré. Quand tous les bulletins de vote ont été comptés, les nombres sont additionnés.

13. Sont élus en premier les deux candidats qui, dans chaque colonne, ont acquis le plus grand nombre de votes. Quand deux candidats d'une même catégorie ont obtenu un nombre égal de votes et ce nombre est plus grand que celui de quelque autre candidat dans cette catégorie, ils seront considérés comme élus ensemble. Quand trois candidats ou plus dans une même catégorie ont le même nombre de votes et que ce nombre est plus grand que celui de quelque autre candidat dans cette catégorie, deux d'entre eux seront tirés au sort. Quand deux ou plusieurs candidats dans une même catégorie ont acquis un nombre égal de votes et que ce nombre est plus petit que celui obtenu par un autre candidat dans cette catégorie, mais plus grand que celui acquis par un autre candidat dans cette catégorie, un de ces candidats sera tiré au sort.

14. Ainsi quand les six premiers membres du Comité directeur ont été élus deux autres membres seront élus parmi les candidats restants, c.à.d. les deux candidats restants de quelque catégorie ayant acquis le plus grand nombre de votes. Quand deux des candidats restants ont obtenu le même nombre de votes plus grand que celui d'un autre candidat restant, ils seront élus. Quand trois ou plus des candidats restants ont obtenu le même nombre de votes et que ce nombre est plus grand que celui des autres candidats restants, deux d'entre eux seront tirés au sort. Quand les deux situations mentionnées ci-dessus ne se produisent pas et deux ou plus des candidats restants ont obtenu le même nombre de votes et que ce nombre est plus petit que celui obtenu par un autre candidat restant mais plus grand que celui obtenu par tous les autres candidats restants, un d'entre eux sera tiré au sort. Le tirage au sort est mis à exécution par le Président suivant une procédure de son choix. Si plus de deux candidats sont élus d'un seul pays, seuls les deux candidats ayant obtenu le plus grand nombre de

votes ou étant assignés par la procédure décrite ci-dessus seront confirmés. Le vide créé ainsi sera rempli par l'application des articles 13 et 14.

15. Les nouveaux élus du Comité directeur assument leurs fonctions à partir du moment où les resultats sont lus à la Réunion plénière par le Président ou le Secrétariat.

16. Le Président décidera en la matière survenant durant la procédure électorale pour laquelle ces lois n'auraient rien prévu.

17. Immédiatement après l'élection du conseil de direction un président et un vice-président seront élus. A cette fin l'ancien secrétaire qui est responsable de tout ce qui se rattache à l'élection, distribuera des bulletins de vote appropriés. La personne ayant reçu le plus grand nombre de votes sera élu président et la personne qui le suit de près sera vice-président. Dans le cas d'un même nombre de votes pour ces deux fonctions il y aura un second tour de votes entre les candidats ayant reçu le même nombre de votes. Conformément aux Statuts de l'ICOM nulle personne ne peut être président pendant plus de six ans consécutifs.

18. Le plus tôt possible après l'élection du président et du vice-président, le conseil désignera le nouveau secrétaire du Comité.

CONTENTS

AUTHORS' INDEX

A BASIC BIBLIOGRAPHY OF CONSERVATION

THE LITERATURE ON CONSERVATION AND RESTORATION OF ART AND ARCHAEOLOGY

Preliminary Edition, 1978

With Appendix A & B

H.C. von Imhoff with the collaboration of R.L. Feller

C O N T E N T

Content cont.

Organisations Abbreviated

- ICCROM , formerly ROME CENTER
  International Center for the Study of the Preservation and Restoration of Cultural Property
  13, Via di San Michele oo153 Rome, Italy
- ICOM - International Council of Museums
  Maison de l'UNESCO, 1 rue Miollis
  75732 Paris CEDEX 15, France
- ICOMOS
  International Council on Monuments and Sites
  Hôtel Saint Aignon, 75 Rue du Temple
  75oo3 Paris, France
- IIC
  International Institute for Conservation of Historic and Artistic Works
  6 Buckingham Street, London WC2N 6BA England
- IIC - AG, now AIC
  American Institute forConservation of Historic and Artistic Works
  M.Morales, Executive Secretary 1522 K Street N.W.Suite
  Washington, D.C. 2o oo5 USA
- IIC - CG
  International Institute for Conservation of Historic and Artistic Works - Canadian Group
  Box 9195, Terminal Ottawa, Ont. K1G 3T9 Canada
- IIC - UKG
  International Institute for Conservation of Historic and Artistic Works - United Kingdom Group
  c/o the Conservation Department Tate Gallery
  Millbank London SW1P 4RG England
- OAS - Organisation of the American States
  Washington, D.C. USA
- UNESCO
  United Nations Educational, Scientific and Cultural Organisation
  Maison de l'UNESCO, 1 rue Miollis
  75732 Paris CEDEX 15, France

Not to introduce a new scheme the AATA structure of separating topics was applied, as you may find looking at the INDEX.
Some aereas aren't covered yet the way they should be like 'documentation', 'conservation of photographs', 'scientific methodology', 'methods of analysis and investigation' a.o. .
Other fields are covered but not under their specific heading, like 'ethnography'.
It may be advisable to extend the bibliogaphic data, including the number of pages, exact address forrequisition, in or out of print indication, price etc. . There may be the wish to have this as an annotated version in both official languages - the present preliminary edition is english only.
These questions have to be answered by communication to the undersigned or to the board. It is also obviuos that this is a bibliographic tool of literature written and available in the western hemisphere, based on the limited knowledge the present authors have.
It is still hoped that part of what the authors set out to achieve has succeeded.

H. C. von Imhoff
Fribourg, Switzerland

TO MARGRET

Foreword

As the literature in the field of Conservation becomes more and more, and the row of IIC/ Abstracts - AATA Art and Archaeology Technical Abstracts creeps to the second shelve, it becomes increasingly difficult to advise what to read, if a curator, a collector or a newcomer to conservation wants to find his way. By whom is he going to be introduced to conservation in general and by whom into the specific fields?

There is an obvious need foran outline, of what could be a basic library for a Museum Lab, fora Museum Administrator and a readinglist for Conservation Students, which at the same time is critical bibliography condensed to the essentials of what up to 1978 has been written in and about conservation.

There is also to be said that a lot of excellent literature is written in languages which are not the official ICOM - languages English and French. So an approved basic conservation bibliography could be a guideline for the International bodies, such ICCROM, what to publish in a translation.

Furthermore, in quite some conservation laboratories considerable time is spent , in preparation of particular conservation-projects to collect the related bibliography. Some time could be saved would there be a bibliography of the existing bibliographies.

These are the reasons why the Directory Board of the ICOM - Conservation Committee has asked the authors of the following pages to try to prepare a condensed bibliography as a preliminary edition. It is hoped that there will be a reaction from the collegues in the profession on general and particular subjects to allow the authors to correct, enlarge or restrain this preliminary collection in order to be able to present the conservation community with a more finalised version (by definition can there not be a 'final' version) for the Triennial Meeting in 1981.

The aim was to create a tool which permits the interested person - to become well informed about conservation in general
- to allow appreciation of the whole scale of problems of general and specific conservation topics
- to introduce him/her to the problems of care of collections, including handling and moving of objects.

A <u>General</u>

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Zagreb 1978

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preliminary edition

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of

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Appendix B

of

'The Literature on Conservation and Restoration of Art and Archaeology'

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AUTHOR INDEX

AUTHOR INDEX cont.

SECURITE ET CONSERVATION

J. Thiebaut

Que l'on envisage la sécurité ou la conservation du patrimoine culturel, il s'agit toujours d'assurer le maintien de celui-ci, dans son site ou dans son état.

Il y a là élément de fixation qui, immédiatement apparait en contradiction avec le mouvement de la vie: dégradation et vieillissement naturels, circulation des gens et des biens. Le paradoxe s'intériorise dans le cas, classique, d'un objet, bien fixé, pour rendre difficile la tentative de vol et dont la fixation même se révèlera pernicieuse si le même objet pris dans une zone d'incendie ou d'inondation doit être libéré rapidement de ses attaches.

Ainsi deux ensembles devront sous-tendre la réflexion du responsable du patrimoine; l'un ayant un caractère d'analyse plus abstraite: la sécurité au sens strict et étroit du terme pourra se trouver en contradiction avec elle-même ou avec des impératifs de la conservation;

L'autre, plus concrète, tenant compte des caractères locaux de l'implantation: selon le contexte il importera d'établir une combinaison soigneuse de ces deux techniques.

Le lecteur pourra et devra se reporter aux travaux détaillés et majeurs de l'I.C.O.M. sur ces sujets. La présente note n'a pour objet que d'attirer l'attention sur certains conflits mais aussi sur les modes de conciliation entre ces deux grandes techniques de sauvegarde.

Puisqu'il faut d'abord définir rapidement les termes, suggérons ceci: par sécurité entendons les techniques de protection de l'oeuvre contre des agressions brutales de l'extérieur, qu'il s'agisse d'évênements découlant des forces naturelles, de systèmes techniques, d'actes imputables à des êtres vivants, à main nue ou armée.

Par conservation, entendons les techniques de protection de l'oeuvre contre les agressions plus sournoises de l'extérieur, plus lentes, parfois difficilement visibles sauf par des examens périodiques, agressions extérieures pouvant se combiner avec des processus de désagrégation interne, inhérents à l'objet ou influencés par

le milieu.

La différence entre les deux techniques est assez nette: la sécurité vise essentiellement la protection "extérieure" de l'oeuvre, la conservation se préoccupe aussi bien de l'"extérieur" que de l'"intérieur" l'une et l'autre n'assurant que la protection de la matérialité de l'oeuvre à la différence des procédés de restauration qui peuvent faire courir un risque supplémentaire, celui de l'altération de l'"esprit" de l'oeuvre.

Cette parenthèse exclue, l'on peut noter que la sécurité ayant à résoudre plutôt des problèmes d'agressions violentes de l'extérieur emploiera plutôt des techniques d'intervention assez vigoureuses, assez ponctuelles alors que la conservation se devant d'être plutôt discrète et continue aura recours à des techniques plus subtiles, diversifiées, maintenues sur une période plus longue et se situant dans un ensemble plus vaste.

Cette distinction est l'une des premières sources de désaccords ou difficultés entre équipes chargées de l'une ou de l'autre. Cette discorde ne tiendra pas à la finalité dont il faudra leur rappeler l'identité mais aux méthodes. Insistons sur les deux principaux caractères d'opposition:

- action brutale(le mode) et brève(le temps) pour la sécurité (au niveau de l'intervention).
- action nuancée (le mode) et longue(le temps) pour la conservation.

Cependant, dans certains cas, il sera nécessaire d'agir rapidement pour assurer la conservation de l'oeuvre: modification brusque de l'environnement par exemple.

C'est au niveau, visible, de l'intervention rapide que peut s'estimer prioritaire l'équipe de sécurité, son action se déroulant dans des circonstances plutôt spectaculaires mais il ne faut pas non plus que l'équipe de conservation s'arroge la primauté par l'argument de la défense permanente de l'intégrité de l'oeuvre.

Les deux équipes y concourent chacune à leur manière et avec leur mission propre. Pour désamorcer les conflits il faut fermement déterminer leur part respective et complémentaire et les accoutumer à un travail en commun chaque fois que possible et impérativement lors de l'établissement d'un programme de sécurité ou de conservation, lors d'une modification de ce programme, lors de l'étude de matériels et de méthodes pour mesurer en commun les risques subis ou évités et chercher en commun les solutions d'amélioration.

D'ailleurs, avec la finalité majeure,deux terrains d'entente se découvriront, ceux de la <u>prévention</u> et du <u>progrés</u>. Dans l'une et l'autre des conduites la démarche sera proche et si possible commune; analyse

d'ensemble, examen des données chiffrées, essais comparatifs, réflexion sur les résultats, recherche de solutions meilleures au fur et à mesure de l'expérience acquise et de l'évolution des facteurs modifiant le schéma initial.

C'est ce schéma initial qu'il importe de considérer en premier lieu du double point de vue de la sécurité et de la conservation. L'analyse peut être plus aisée lorsqu'on se trouve dans le cas d'un projet de création de site, dépôt, musée encore que l'abstraction même des conditions réelles de fonctionnement puissent conduire à certaines surprises.

Il est plus malaisé d'embrasser clairement les différents éléments du système lorsqu'on se trouve confronté à un site ou un établissement comprenant des oeuvres, recevant du public, qu'il faut améliorer, aménager, doter d'espaces ou de services nouveaux mais, au moins, dispose-t-on là d'éléments réels de fonctionnement.

Dans le premier cas, il s'agira d'une hypothèse de base et de proposition de variantes permettant une mise en service adaptable en fonction de l'évolution de certaines données. Dans l'autre, il s'agira d'un constat mais aussi de propositions de variantes prospectives pour assurer un fonctionnement satisfaisant au moins durant une certaine période.

Rien ne sert de se leurrer, en matière de sécurité comme de conservation, établir un système efficace mais souple, le maîtriser, l'aménager si nécessaire est affaire de programmation et suppose impérativement l'analyse aussi exhaustive que possible des facteurs en présence et la recherche rigoureuse des combinaisons optimales. Et, dans ce parcours de la connaissance, il ne faut pas omettre de faire appel aux gens de terrain, à l'expérience des personnels de surveillance et d'entretien qui notent des aspects pratiques et quotidiens fort éclairants pour la prise de décision et d'instructions.

Certes la conservation, peu ou prou, a été généralement analysée et organisée dans de nombreux cas pour la principale raison que l'on a traditionnellement accordé la première importance à l'oeuvre avec cependant bien des réserves encore sur ce point.

L'on a ensuite pris conscience qu'un patrimoine culturel incluait autour de l'oeuvre; bâtiments, systèmes techniques plus ou moins sophistiqués d'éclairage, chauffage, climatisation, animation, signalisation mais aussi des personnels employés plus ou moins régulièrement et un vaste public constamment renouvelé et souvent peu conscient de certains dangers attachés à des lieux de grand rassemblement et de présentation d'objets protégés en raison de leur fragilité et de leur rareté.

Parfois, cette prise de conscience de la nécessité d'installer rapidement des systèmes de sécurité peut paraitre mal à propos pour des responsables de la conservation s'étonnant des moyens considérables consacrés

à la sécurité alors qu'ils plaident depuis des années pour l'accroissement des moyens de la conservation. Parfois, des décisions hâtives, des compétitions entre installateurs, des systèmes mieux adaptés à des bâtiments commerciaux ou industriels qu'à des espaces culturels entrainent difficultés, gênes, malentendus, mécomptes, incidents irritant les personnels et le public.

Dans la majorité des cas, la conservation ayant un caractère d'antériorité, il convient d'associer trés étroitement ses responsables à la réalisation du programme de sécurité. L'inverse est vrai également. Sous le nom de responsables de la surveillance ces personnels ont une antériorité analogue.

Leurs attributions et leurs responsabilité se trouvant accrues, peuvent provoquer assez logiquement des revendications ou demandes d'amélioration des statuts. Il convient d'y faire droit et de procéder à une mutation délicate car apparaissent alors les distinctions entre les tâches classiques d'accueil et la surveillance du public et de l'objet, et les tâches plus nouvelles de surveillance de système électro-mécaniques et d'interventions spécialisées à l'égard du public et de l'oeuvre.

Il faut aussi, absolument, sensibiliser les personnels nouveaux ou ceux qui sont passés dans la nouvelle catégorie aux conséquences possibles sur la conservation de l'oeuvre, du fonctionnement des nouvelles installations techniques et des systèmes d'organisation mis en place.

Donc, dans les deux cas, équipes de conservation et équipes de sécurité doivent être bien informées des sujétions et des contraintes afférentes aux deux programmes.

Autre question classique, survenant alors, celle du pouvoir hiérarchique dont relèvent les responsables de la sécurité. Ancienne formule: la surveillance était traditionnellement subordonnée à la conservation détentrice de l'érudition et de techniques simples de conservation, généralement responsable du site ou de l'établissement, cette subordination se muant souvent en une association confiante et une délégation partielle de pouvoir généralement justifiée. Nouvelle formule: surveillance et conservation traditionnelle éprouvent un sentiment de relégation devant les troupes montantes de la sécurité et d'une conservation formée à des techniques plus élaborées car, là aussi, une mutation s'opère.

Un responsable de site ou d'établissement formé à la fois à l'érudition et aux techniques approfondies de conservation, dirige à la fois l'équipe de conservation et l'équipe de sécurité qui relèvent directement et indépendamment de lui. Cette indépendance est maintenant généralement admise par le fait de la spécialisation croissante des tâches et de la prise de consci-

ence des enjeux mais la fonction de responsabilité au sommet appartenant à un scientifique, la tendance sera la subordination relative de la sécurité à la conservation.

Il appartient au responsable du site ou de l'établissement, en cas de conflit, d'arbitrer et de prononcer le choix entre la conservation et la sécurité selon la circonstance et la hiérarchie locale des valeurs qui l'améneront parfois à privilégier l'oeuvre, parfois la personne. Il y a une certaine propension, actuellement, à préférer cette dernière sous l'effet d'une certaine évolution des idées et des comportements sociaux.

Si l'autorité sur le site ou l'établissement appartient à un administrateur, assisté d'un collège scientifique et technique, gageons que pour des raisons d'ordre politique, la décision pourra être davantage influencée par la sécurité.

Un certain recul de la conservation parait donc notable. Ce recul peut s'atténuer si les responsables de la conservation possèdent des connaissances techniques suffisantes et acceptent d'ajouter à leur capital intellectuel une qualification nouvelle en matière d'administration et de sécurité. Mais, cette nouvelle responsabilité entrainera inévitablement une sélection plus sévère et de ce fait, une révision de leur statut, rémunération et conditions de travail. Responsables des lieux, ils deviennent également et plus clairement responsables des personnes. Les voilà en chemin pour exercer une fonction de chef d'entreprise, une fonction d'autorité nouvelle réduisant inexorablement la part du travail scientifique également entamée, bien que ce ne soit pas dans ce propos, par les exigences des nouvelles fonctions d'animation et de diffusion dans le public.

L'émergence de la notion de sécurité met en question le schéma traditionnel de la conservation du patrimoine culturel.

Entrainera-t-elle une spécialisation et une nouvelle division des tâches à l'intérieur d'une unité de conservation. Un glissement peut s'opérer, tendant à confier la responsabilité générale de l'unité à un personnel formé à l'administration générale, arbitrant les secteurs scientifiques, techniques, de surveillance, d'accueil, d'animation, de sécurité.

La pression du nombre, l'accroissement de la demande entraînent, obligent à l'organisation, à la prévision. La culture devient un élément de la politique. Elle est l'objet d'études quantitatives, elle s'insère dans un budget, une comptabilité nationale. La sécurité, épiphénomène ou avertissement ? La défense, la conservation du patrimoine vont, doivent se référer à une nouvelle science, à de nouvelles techniques, à de nouvelles disciplines, exigent une conscience élargie à la mesure

de l'époque.

Après avoir essentiellement évoqué les personnes, les difficultés venant principalement d'eux, d'une incompréhension, d'une ignorance, d'un travail mal exécuté ou effectué de façon trop isolée, il faudrait procéder à un examen détaillé des rapports entre la sécurité et la conservation. Un recensement complet serait nécessaire. Il pourrait faire l'objet d'un groupe de travail mixte qui affinerait, controuverait éventuellement les quelques directions esquissées ci-dessus.

Schéma proposé, à titre indicatif:

<u>Sécurité</u>	<u>Définition des risques</u>		<u>Conservation</u>
des			contrôle de
objets monuments sites bâtiments espèces vivantes personnels publics (adultes) (enfants) (handicapés)	vol incendie explosion vandalisme léger destruction agression	objets monuments sites bâtiments espèces vivantes - -	l'atmosphère du climat l'éclairage manutention intérieure transports extérieurs

<u>Définition et compatibilité des systèmes de prévention</u>

Prévention des risques — Prévention des risques

<u>Définition et compatibilité des techniques d'intervention</u>

Techniques d'intervention — Techniques d'intervention

Compatibilité interne des systèmes de sécurité — Compatibilité interne des systèmes de conservation

Compatibilité entre les systèmes de protection des personnes et les systèmes de protection des oeuvres

<u>Arbitrage</u>
<u>Limites des systèmes</u>

- visibilité ou discrétion
- information ou secret
- facteurs et conséquences psychologiques.

Aspects juridiques

- législation et règlementation pour la protection des oeuvres et des personnes
- systèmes d'assurance des biens et des personnes.

Inventaire comparatif.

CONCLUSION

- la sécurité renforce-t-elle la conservation ?
- la sécurité améliore-t-elle la conservation ?
- la sécurité contredit-elle la conservation ?
- une politique de sécurité étendue comporte-t-elle des risques de contradiction interne et d'incompatibilité avec la conservation ?
- une politique de conservation étendue comporte-t-elle des risques semblables ?
- cas majeurs d'incompatibilité interne ou duale déterminant l'établissement de recommandations essentielles.
- propositions en vue de compléter les textes juridiques de protection des oeuvres et des personnes.

RESUME

La conservation a élaboré des méthodes et une politique de protection de l'oeuvre depuis longtemps. La sécurité qui vise aussi la protection de l'oeuvre s'étend également aux personnes. Des conflits peuvent surgir et rendent délicate l'application des deux programmes. Une information réciproque et une réflexion commune sont nécessaires. Pour éclairer la question, un schéma d'analyse est proposé à un groupe de travail mixte réunissant spécialistes de la conservation et de la sécurité.

SACRISTICAL CABINET FROM St. JOHN'S THE BAPTIST CHAPEL IN FRATROVCI

V. Gobeljič and B. Lučić

A B S T R A C T

SACRISTICAL CABINET FROM ST. JOHN'S THE BAPTIST CHAPEL IN FRATROVCI

In the village Fratrovci's chapel near Ozalj (Western Croatia), the sacristical cabinet was discovered as a masterpiece of the domestic St. Paul's artistic school of the 17th century. The cabinet was ceded for the future museum's collec tion in the palace of the old town Ozalj.

The cabinet consists of two parts. The bottom part is deeper, so that behind the working plane stands the smaller upper part. The cabinet is 245 cm high, 153 cm wide and 97 cm deep. It has a linear and symmetric shape. The cabinet is framed with a cut out frame in black, which like a silhouette leaves the impression of the volutes. In each of the bottom doors there is pictured a jug with flowers. In the upper door there is illustrated "The Annunciation". All the other planes are decorated with marble like painting.

The cabinet was rather neglected. The wood was ruined by worms and in some places the colour was missing or dusted off. Desinsection by metil-bromide was made immediately in the workshop. After carpentry works all wooden planes were drenched in wax. The pictured planes were retouched by oil paints directly on the board without any other base. The side of the cabinet which was illustrated was protected by mat shellac. Desinsection by "Xylamon" was then done. Since the works began, a documentation was being made which was prescribed in the workshop of the Croatian Institute for Restauration. The work was done in the year 1977/78th.

In the picturesque countryside where hills descend to the river Kupa, not far from Ozalj, lies the small village Fratrovci. The name is a reminiscence of the once standing estate of the "White friars" a name given by our people to the monks of St Paul. In this village's chapel the sacristical cabinet described in paper was found.

A few ago, art historian Dr Đurđica Cvitanović ascribed this illustrated cabinet to the domestic scholl of "St Paul's" order of the 17 century and suggested its restoration. It is judged that this cabinet has special significance, taking into consideration the extermination of the powerful Croatian aristocratic families Zrinski Frankopan (1671) and the abolition of St Paul's order by Joseph II (1786). Thus, to a considerable degree, the cultural inventory of the 17-th century in Western Croatia was much rarefied. Then, by the initiative of the curator of Ozalj's museum collection, prof. Martin Vajdić, the cabinet has been generously conceded to the possession of the mentioned collection. Its final location after restauration was assigned in a room together with other preserved remainders of wall paintings in the palace of the town Ozalj. The palace had been arranged in 1556 by Nikola Zrinski who was killed while defending Siget from the Turks. This building served as a palace until the Zrinski family were ruinned and then later owners used it as a granary. Today this very interesting building is being renoveted so that part of Ozalj district's museum could be placed there. Besides the already mentioned wall paintings on theme of Christ's agony (made in the second half of the 16th century) were discovered in the original layers of paint and plaster in this

and an ajoining room, being a very significant graffiti written in middle-aged Croatian letters "Glagolitsa". Many of them were written in Latin, and naturaly in capitals. On the palace have been preserved the architectural elements sculptured in the stone such as portals, windowsills, small benches, furnaces and similar. All, mentioned details are very important for estimating the cultural circumstances here and this extreme decay of the building, enables us a quite special approach to its presentation so that the building itself shall be, with remaining original values, the basic exposition. In such a presentation,in which stratification of the building would come to its full expression (Nikola Zrinski built his palace on an object that had already existed, probably a fortification), besides the foreseen video and audio devices, there also would be things that come from the Ozalj district. Such objects point out the wholeness of architecture and its mobility in the past. This cabinet helps us interpret the significance of 17th centruy the cultural centre of Ozalj and St Paul's monistery in Svetice.

The cabinet was to function as the sacristy's cabinet. It consists of an upper and bottom part. The upper part, between two horizontal rows of drawers, is closed by two doors. The interior behind the doors is simply partioned by a shelf and cross boarded in four parts. This section served for keeping books needed for the liturgy as well as mass vesels. The upper, a smaller part of the cabinet, is situated on the bottom part which is wider and significantly deeper. Cover boards of the bottom part of cabinet are also partly working planes needed for taking and storing the things kept in the cabinet. The front covering board protrudes on each side of the cabinet's gabarit.

The bottom part of the cabinet is closed by two doors. The interior of the cabinet is filled in its entire width by five drawers in which mass vestment were kept. The

cabinet is mainly made of oak and a frame that is carved of linden. The cabinet's sahpe is linearly conceival with a realised symmetry. The frame was cut of board, which silhouetticly leaves an impression of volutes with carved cartilaginous motive, which is characteristic for an earlier age. There is a similar frame on the altar in the castle's chapel of St Maria in Gornji Tkalec from 1628 (see: A. Horvat; Between Gotic and Baroc, Zagreb 1975, pp.391, picture 33o). This plain frame is painted in black. The bottom doors, that are richly, arnated bands made of wrought iron placed on simple pivots and a multicoloured marblization by a diagonal successeion of vains. A middle panel whose upper corners are protruded and framed with profiled lattice. In the middle panels a glass jugs with flowers are pictured on a table. The interior of the cabinet is also pictured but in a more simple way. Simplified marblization on the in side of the doors together with the colour emphasizing the profiled frames of the drawers and soothe the transition from the intensive multicoloured outer appearance. The upper a significantly shallower part of the cabinet lays on the covered boards of the bottom part. Transition is solved with a profiled board, which is the basis of the upper part of the cabinet. Four drawers that have profiled frames give an impression of a gently drawn plane above which are protruding doors. Like the bottom doors these have richly ornated metal fittings. They are also coloured with a marblezation of diagonally vascular successions, while in the middle penels protruding upper corners the "Announciation" is pictured. In the left middle panel there is the archangel Gabriel blessing, and in the right hand there is the figure of Virgin Mary who is humbly receiving the news. The figures are pictured from the waist up, thus giving the impression as if thev wereportraits. (Detailed work and anlysis of the paintings of the "Annountiation" goes beyond the frame of this paper). It should be emphasized that the midd-

le panels have been pictured "alla prima" and without a basis, but directly on the board, as the vase with flowers and everything else. Small drawers above the doors, as well as their accelerated rhythm introduces into the finishing cornice of the cabinet together with classisally concepted profile of astregal above the drawers and up to withdrawn and profiled conclude the finishing part. On the drawers and on the cornice there is an interchange of redish and yelovish colour and with marblization of the red, green, blue, violet and brownish tones on the door frames and thus giving the impression of splendour that has separated within a firmly boarded achromatically serious black frame. The cabinet is 245 cm high, 153 cm wide and 97 cm deep. The condition of the cabinet before its coming to the workshop had been one of neglect. The cabinet was dry rotted i.e. all joining boards hal clefts. In some places there were small missing parts as profiled lattice, drawer frame, drawer handles, the wooden edges of the front covering board had been sawed off, on the left side one part of the frame was missing, and on the right side the panelfilling had fallen out.

The entire cabinet was covered with worm holes. The pictured surface was molded with dirt and the colour had become dusty and thus in some places the paint had fallen off, for example on the cabinet's frame and pictured door. Especially damaged were the pictures in the middle panels of the bottom doors picturing a jug with flowers.

The elaborate program of the protection works on the cabinet foresaw the renewal of the mentioned defects including measures for the cabinet's further existence.

Upon arrival to the Croatian Institute for Restauration workoshop the cabinet immediately underwent a preventive desinsection by the gas metil-bromide. Then, the usual photo-documentation was made and a detailed account of the condition before the conservation-restoration was started. Besides the photographic part, photographs of a

black-white format of the negative 6x6 cm were made and the photographing was acomplished in colour slides of the "Leica", a sketch which fixed the snap shot at a proportion 1:lo. After the carpentry work, all the additional parts were made from the same sort of wood and in the same shape. The whole surface of the cabinet was soaked under the iron of a wax mixture. With the same mixture the clefts and fissures were filled which were left after the carpentry work. In the pictured middle panels the closing of the fissures and small pores was accomplished with the wax mixture of 4 parts wax to 2 parts calofonine, 1 part of Damar tar, and 1/2 part Venecian therpentine. The pictured middle panels were restored by oil paints by which the original had been painted. The panel was directly retouched without any ground foundation like we have already constituted - as the original painter had done. At first all the damages had been shaded on all the pictured surfaces in the same approximate neutral shade that at last with further improvement and the complete effect was one of a harmonized unity on the original painted surfaces. In retouching, we used the colours produced by "Schmincke", diluted with balsam therpentine of the domestic production "Aero", two times rectified. In the last intervention with paint has been accordingly to the need drifted more in the form of paste so that it would harmonize with the original. The retouch of the missing paint on the frame has been accomplished by picturing in "Roman retouch" so that it could achieve the same colour with our work. The entire pictured side of the cabinet was protected by a mat shellac. In the workshop the wood was treated with insecticide substance "Xylamon+Combi-Hell" produced by Bayer - Dessowag. From the beginning to the end of the work in all phases and all observations were put in a work file record. The work was done in the workshop of the Croatian Restauration Institute by the following group: Velislav Gobeljić, artist; Franjo Mrnjec, master gilder and carver; Emil Pohl, artist,-head of the workshop; Đuro

Šimičić, artist; prof. Branko Lučić, conservator - art historian and Mira Tomičić photographer.

The works were done during the winter season 1977/78 th.

NEW APPLICATIONS OF METHODS OF EXAMINATION

Coordinator : H.C. von Imhoff (Switzerland)
Assistant coordinator: Ch. Lahanier (France)
Members : A. Breccia (Italy)
D.L. Greenaway (Switzerland)
B. Hallström (Sweden)
J.H. Hanlan (Canada)
D. Hollanders-Favart (Belgium)
M. Liétaert-Parmentier (Belgium)
C. McCawley (Canada)
F. Mairinger (Austria)
M. Museus (USSR)
W.W. Percival-Prescott (U.K.)
C. Perier-d'Ieteren (Belgium)
M.A. Raggi (Italy)
F. Schweizer (Switzerland)
S. Sciuti (Italy)
L.M. Teixeira (Portugal)
J.R.J. van Asperen de Boer (Netherlands)
R. van Schoute (Belgium)
H. Verougstraete-Marcq (Belgium)
A. Voûte (Switzerland)

Programme 1975-1978

1. a) Improving the pre-existing radioisotope XRF portable unit in order to have a miniaturised data processing sorting (Sciuti);
   b) improving patina composition studies in ancient alloys (Sciuti);
   c) improving pre-enrichment methods in order to XRF analyse ancient fragments with minimum detectable limits per chemical element down to 0.01 p.p.m. (Sciuti);
   d) improving Cf^{252} neutron techniques (Sciuti).
2. Localisateur optique en analyse par microfluorescence X - Application aux pierres dures (Lahanier).
3. Elaboration de méthodes nouvelles d'examen optique de peintures (Museus).
4. Les nouveaux matériaux sensibles et leur application dans la photographie du spectre invisible dans l'examen des oeuvres d'art (Teixeira).
5. Use of diamond-cell infrared spectroscopy in specific areas of conservation - further development (McCawley).
6. A study of the possibility of applying Mossbauer effect spectroscopy to a study of the corrosion and reduction of iron (Hanlan).

7. Possibilities of dating of works of art (Polarimetry, electron fluorescence, etc.) (Breccia).
8. X-ray fluorescence analysis of metal objects - possibilities and limitations (Schweizer).
9. The use of UV-reflectography in the examination of works of graphic arts (Mairinger).
10. Development of optical methods for the identification and measurement of surfaces by means of spectral analysis (Greenaway).
11. Radiographie en couleurs (Van Schoute, Liétaert-Parmentier, Verougstraete-Marcq).
12. IR-reflectography: problem Maître de Flemalle - Van der Weyden (Van Asperen de Boer, Van Schoute).
13. IR - confrontation des procédés (Hollanders-Favart, Verougstraete-Marcq, Van Schoute).
14. Improvement and simplification of photographic examination techniques in conservation (Hallström).
15. High resolution micro-radiographic technique for the examination of paintings (Percival-Prescott).
16. Research project on the possibility of pigment identification with photographic techniques (continuation) (Von Imhoff, Voûte).
17. Application of differential thermal analysis and thermogravimetric analysis (McCawley).
18. La réflectographie infrarouge dans l'examen des peintures flamandes des XVème et XVIème siècles (Perier-d'Ieteren).
19. Spectroscopic techniques in the examination of fungi on works of art (spec. mural paintings) (Raggi).

WORKING GROUP NEW APPLICATIONS OF METHODS OF EXAMINATION

From non-destructive to 'non-destructive' to N.A.M.E.

A bit of conservation history

Coordinator: H.C. von Imhoff
Musée d'art et d'histoire
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- The fascination of revealing information about paintings using other means then visible light and the naked eye, and the useful application of these informations to conservation was the starting force,
- the awareness that science for a time did seem to overlook the importance of these techniques as a tool for the conservator, was one thriving concern,
- the other their non - destructive aspect
- the ICOM Conservation Committees second Triennial Meeting in Amsterdam in 1969 was the occasion
- and the boat trip on the Zuidersee the igniting moment for the founding of the working - group:
  ' Non - destructive methods of examination of works of art and their practical application'.

Initially a purely european group, consisting of F.Mairinger(Austria), P.Mora (Italia), R. van Schoute (Belgium) J.R.J. van Asperen de Boer (Netherlands), A, Voûte (Switzerland), R.H.Wackernagel (FRG) and the undersigned the group formulated its program:
- compilation and study of the literature
- research into recent improvements in matters of non - destructive examination
- a critical study of their possibilities of application
- the distribibiution of the results
(ICOM - News , Vol.22 , Nr. 4, 1969, pg. 24/57).

<u>1969 until 1972</u>

This way structured and motivated the group received the blessing of the directoryboard of the Conservation Committee and some time later even a small grant from the Rome Center to organise a small international interim meeting in April 1972 in Zuerich, hosted by the Swiss National Museum in their studios for the conservation of paintings and polychrome sculptures and their Research - Laboratories with financial assistance also from privat industry (WILD, RCA, Kodak, F.Biemann AG).
18 participants went through a 3 day working meeting, discussing papers to be deliverd at the 3rd Triennial Meeting of the ICOM - Conservation Committee in Madrid in october of the same year 1972. The topics reached from soft X-rays to Infrared False Colour Photography, Radiography on paper and in colour and included the optical comparator and its possible use, as developed by RCA - Europe.

One topic on the agenda was <u>the word non - destructive</u> in the name of the group, which as of the start had led to discussions. In 197o the seminar on the application of science to conservation, helt in Boston, had fomulated a motion, asking to avoid the use of the terms ' non - destructive testing' and ' non - destructive analysis'
In a letter from the ICOM - CC - Secretary P.Philippot we were asked to comment on the significance of this word in our group - title. In a text, intensly discussed during the Zuerich - meeting, the group agreed as for the relative chracter of the term non - destructive in the percise and scientific sense of the word, but could not agree on any other term to respond to the particular preoccupation of the group - it was proposed to use the term non - destructive in exclamtion marks.

The presentation of the group's papers in Madrid 1972 (IIC - News, August 1973, supplement to SIC Vol.18, No.3) left the impression that the group represented a real concern of the profession. This was not only obvious when counting the listeners in the lecture hall, but also through the amuont of demands for enrolement as a member of the group .

One of the problems inherent to the structure of the ICOM - Conservation - Committee also caught up with this group: the <u>problem of overlapping</u> with programs of other groups: topics, which would be presented in one group would also fit another groups program, f.e. the Voûte - von Imhoff project on pigment identification - to some extend it belongs to the program of the group then called

'pigments in paint' (Coordinator H.Kuehn), but as a new methodological approach and as application of ' non - destructive ' techniques it fell as doubtless within the field covered by the 'Non-destructives'.
A cure for problems of this kind seem difficult.

1972 until 1975

The Madrid program of the group for the period '72 to '75 (never published) still contained topics mostly related to the initial preoccupations of the founding members: 'visual information about unvisible facts'. The list of papers actually delivered under the working - groups heading showd some change (ICOM - CC, 4 th Triennial Meeting, Venice 1975, Preprints, pg. XVIII):
About half the contributions were presentations of conservation - scientists, introducing methods of scientific investigation not yet applied to conservation, throughout so as adaptations of existing techniques to conservation.
We aren't jet were G.Thomson wants to see conservation science, but probably some approach is made in his direction ('Conservation Science - the Next Stage', Garry Thomson in Museumnews 4 / 1966).
1972 the group had formulated its three main interests as being:

- methodology of the use of variuos means of investigation
- application of new discoveries
- solving concrete problems in art history

1975 it became evident that a change in name would be appropriate to reflect the developement. It therefor discussed a text and submitted it to the Directoryboard for approval: The proposed new name was :
'Methods of examination, techniques and developements'

' The group: 'Non - destructive ' methods of examination of works of art and their application ' has after intensive discussions decided to submit request to change its title in order to be able to cover the whole field of examination, with aim to report progress in the utilisation and the interpretation of known mehtods and techniques, as well as to introduce techniques not used in conservation research up to now.

At the directory board meeting in Rome in February of 1976 another name for the group was decided on:

New Applications of methods of Examination (N.A.M.E.)

The group has developed considerably since its first discussions on the boat tem years ago - so has conservation. It is very satisfiing to see the group extend over 4 continents now, to see that preoccupations of the beginning have developed and a more systematic approach is mede to use 'non - destructive' techniques - especially the ones which are based on optical perception;
There have been two international meetings arranged in Louvain, Belgium by R. van Schoute, founding member, on the topic ' Underdrawings in paintings ' with all the arthistrical implications considered,-Mairinger, also a founding member has published a paperback ' Untersuchungen von Kunstwerken mit sichtbaren und unsichtbaren Strahlen '
- in June of this year an exhibition is sceduled to open in Braunschweig,Germany , entitled 'Gemaelde im Licht der Naturwissenschaft' a.o.

Assistant Coordinator

Another important developement had consequences for NAME, as the groups new title can be abbreviated, the conservation Committee's instituting of the Assistant Coordinator. as a new function in all working groups.

NAME members elected C.Lahanier (France), a conservation-scientist to fill this position, which he did in an excellent way, not only often acting for the coordinator, but also by providing ideas as to how the group could become more active, useful and efficient.

1978 and onward

Out of discussions with the assistant coordinator developed a project which I sincerely hope will take shape during the Zagreb meeting, to create an inventory of specific scientific equipment with its location in conservationresearch-facilities or similar institutions and indications as to who is specialised in dealing with this machinery.
The advantage of such an inventory does not need further elaboration.

The new definition of the scope of this working - group does bring up the question if the structure of the group is adaequate and the definition of what is a member satisfactory. Untill now one was considered a member the moment this person submitted a proposal for a research project, on the progress of which he or she would report duting the next triennial meeting, with the provision always that he was first accepted by the coordinator and then by the directory board of the Conservation Committee(art. 4.1.)

Being in charge of continually reporting on developement and progress of applications and innovations of methods of investigation, this definition of what is a member does, not necessarily produces the desired results.
It is therefor proposed to change this habit for this working-group and have continuos members, who take upon themselves to be observers of what is happening in 'our' field, in a defined region (USA , Southeast Asia o.e.). They could be even acting as regional coordinators. These members would inform the cordinator or his assistant on a regular basisabout their observations and findings and give a resumé during the Triennial meetings if so desired. They also would propose individuals to be invited to present their work, as they find it informativ and of real interest for conservation.

The coordinator's and his assistant's job would be to
- disseminate information to the members what elsewhere is happening
- to pinpoint important developements
- to instigate research
- to help to avoid costly duplication
- to cordinate efforts in the field.

I feel so structured the group would be much better equipped to provide up to day information. This seems important not only for conservationscientists, but more so for the non - specialist in investigation - matters, as there is nearly no possibility to have regular information on this topic in any conservation journal and little in seminars. It will depend on the presentmembers as to wether these ideas seem acceptable and feasable.

To conclude the ' non - destructive ' period of this working-group, a review will be made of all papers presented, including the Zagreb ones. It might prove very useful to have the more important ones updated and gatheredcto be edited in the series 'Travaux et publications' ('Reports and papers on museums').

A METHODOLOGICAL APPROACH TO THE STUDY OF THE DETERIORATION OF THE STATUES IN THE BOBOLI'S GARDEN (PITTI PALACE, FLORENCE) 3. RAPID DETERMINATION OF GYPSUM ON MARBLE BY INFRARED SPECTROSCOPY

Piero Frediani and Ugo Matteoli

Summary

A rapid infrared determination of the amount of gypsum present in marble by infrared spectroscopy on a solid sample has been developed. A very small sample, about 1 mg, is mixed with potassium bromide and made into a disc according to the usual technique. The absorbances at 877 cm-1 and 602 cm-1, which are proportional to the concentrations of gypsum and marble are measured. The accuracy of the method within a 6 - 94 % concentration of gypsum is 3 %.

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The process of alteration of stone exposed to atmospheric agents is generally described as taking place through an initial increase of the specific surface followed by the subsequent loss of cohesion of stone layers parallel to the surface, with formation of crusts, which then leads to the total collapse of the material [1 - 3].

The first stages of this process are mainly due to temperature and humidity variations; gypsum appears at a later stage as the result of the subsequent deterioration.

A relevant diagnostic value on the state of conservation or, more properly, on the state of deterioration of works of art in stone has been attributed to the presence of gypsum on their surface.

In the sistematic study of the process of deterioration of the statues present in the Boboli's garden we have recently suggested (Athens 1976 [4]) the determination of the chemical composition of stone, with particular reference to its gypsum content, as one of the parameters describing its state of conservation.

The usual methods for the quantitative determination of gypsum are tedious and need an appreciable amount of material.

In our research program however a large number of samples, available in a relatively small quantity, were to be analyzed, and therefore a simple and rapid method for determining gypsum in stone appeared necessary.

In principle an infrared spectroscopic analytical method could be the answer to our problem [5 - 11].

Other quantitative determinations of solid materials such

as quartz and asbestos by infrared spectroscopy have in fact been reported [12, 13] .

The infrared spectrum of $CaSO_4 . 2H_2O$ (gypsum, fig. 1) shows in fact a characteristic band at 602 cm-1 while $CaCO_3$ (marble, fig. 2) shows a band at 877 cm-1 14 , in regions otherwise free. The composition of a mixture of marble and gypsum could therefore be determined from an appropriate evaluation of the intensity of these bands.

The infrared spectrum of a sample containing a mixture of gypsum and marble in the region 1000 - 500 cm-1 is reported in fig. 3 .

Results and discussion

Several mixtures of gypsum and marble of known composition (table 1) have been prepared, their infrared spectra were recorded and the absorbance of the bands at 877 and 602 cm-1 measured. In table 1 the relative absorbance of the band due to gypsum in the mixtures examined and the corresponding quantity (by weight) of gypsum are reported.

The spectra have been recorded directly in absorbance. The height of the absorption band at 877 cm-1 has been measured as shown in fig. 3 and gives directly the absorbance of marble; the height of the absorption band at 602 cm-1 gives the absorbance of gypsum.

The relative absorbance of gypsum has been calculated as the ratio between the absorbance at 602 cm-1 and the sum of the absorbances at 877 and 602 cm-1.

Fig. 4 and tab. 1 show that there is a good agreement between the composition of the samples analyzed and the intensity of the bands of the infrared spectra of gypsum and marble in the concentration range explored (6 - 94 % of gypsum). For concentrations of gypsum around 1 % the error becomes exceedingly high.

Bands different from those used to determine the composition of a mixture of marble and gypsum give worse results.

The reproducibility of the method has been determined by repeating the determination on the same samples at various time intervals or on different discs. The results, reported in table 2 show that the standard deviation is less than 0.18.

The accuracy, reproducibility and rapidity verified make this analitical method a useful one for a microquantitative determination of gypsum present in marble statues.

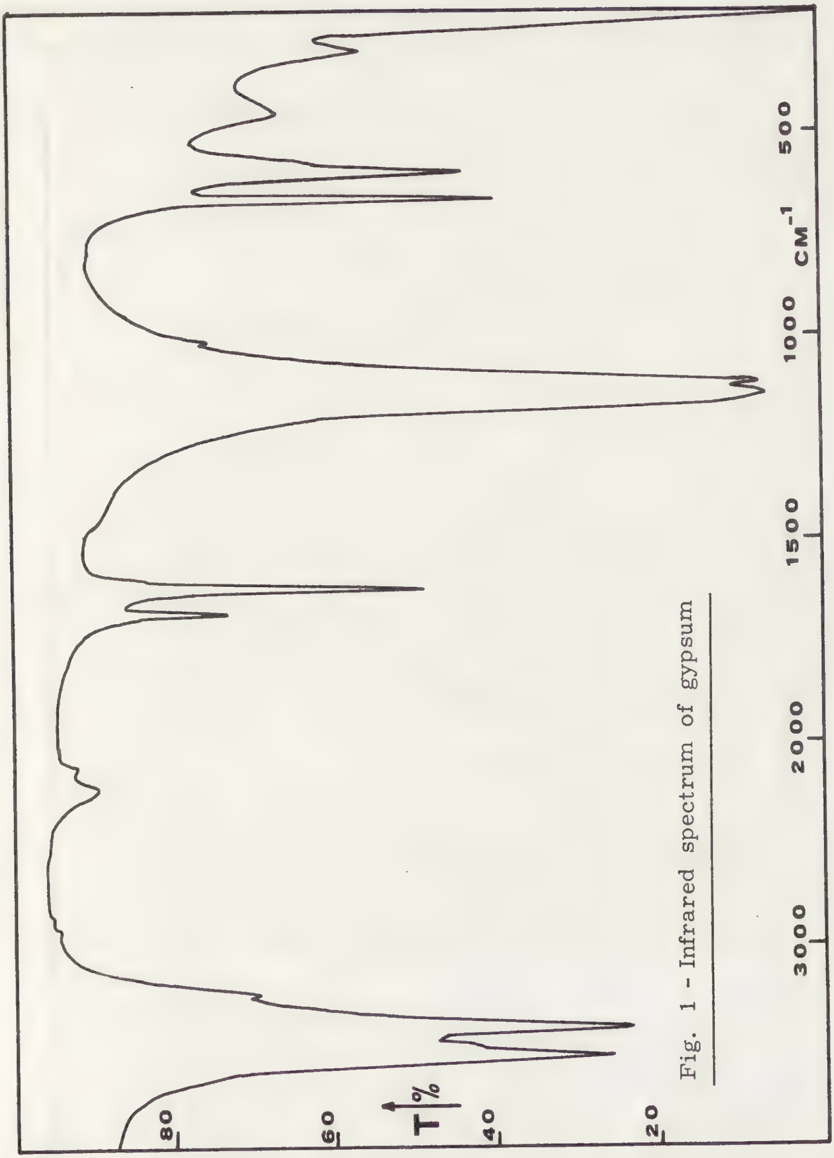

Fig. 1 - Infrared spectrum of gypsum

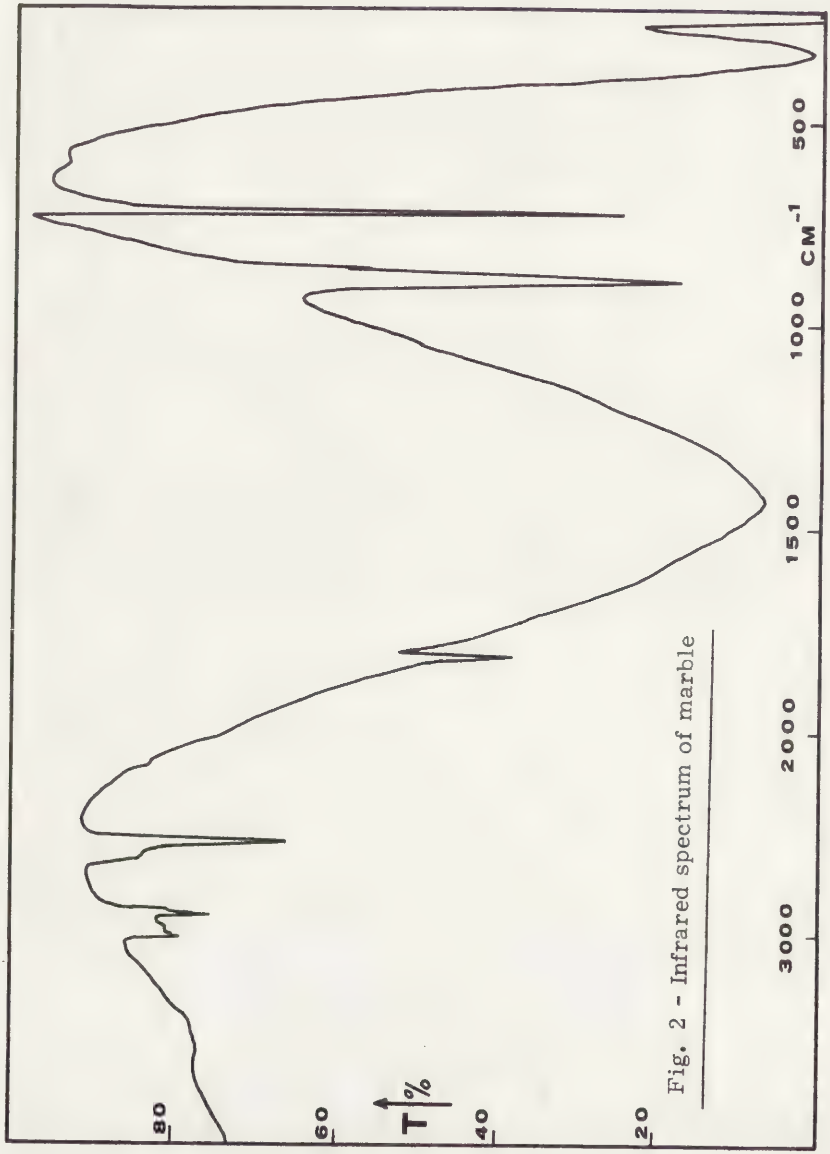

Fig. 2 - Infrared spectrum of marble

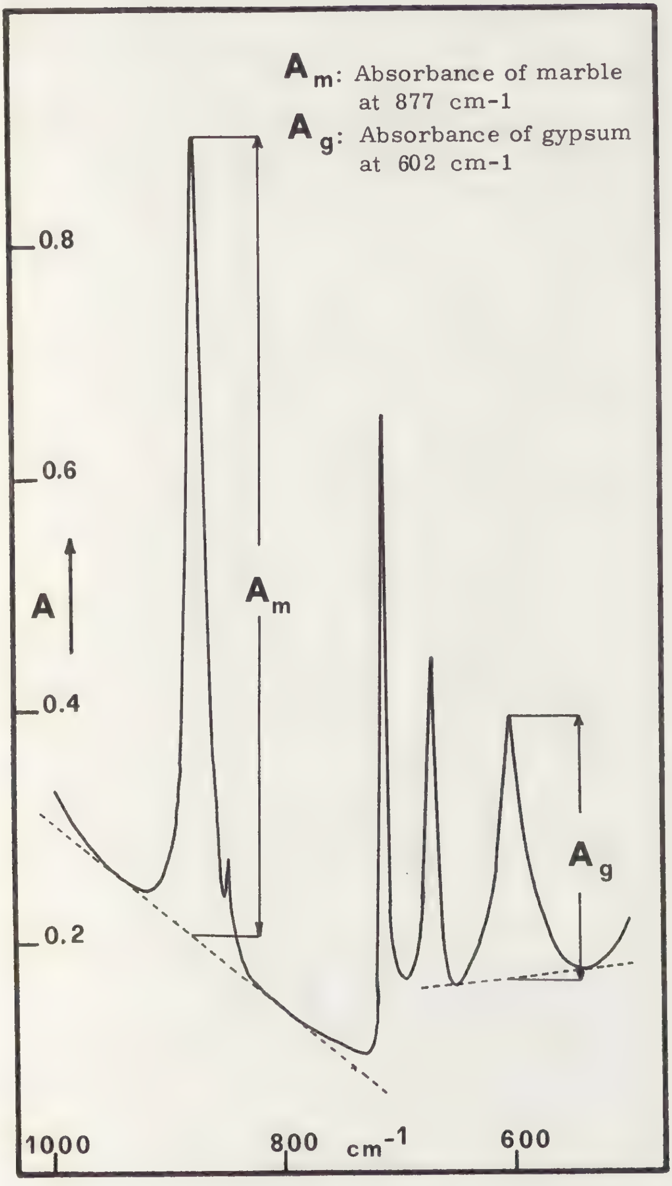

Fig. 3 - Infrared spectrum of a gypsum and marble mixture in the 1000 - 500 cm-1 region.

Table 1

Gypsum in marble: relation between relative weight and relative absorbance.

Sample N.	Relative gypsum weight %	Relative gypsum absorbance %
1	6.25	6.7
2	14.94	15.8
3	19.90	19.3
4	25.14	25.2
5	32.76	34.8
6	38.31	38.2
7	44.66	44.1
8	48.85	52.1
9	53.15	52.5
10	58.75	61.4
11	66.20	65.5
12	74.41	73.0
13	75.35	76.2
14	87.00	85.8
15	94.38	94.4

Standard deviation 3.5%

Table 2

Riproducibility of the measure on the same disc or on various discs of the same sample.

Sample N.	Disc	Spectrum N.	Relative weight of gypsum %	Absolute absorbance of marble	Absolute absorbance of gypsum	Relative absorbance of gypsum %
4	A	1	25.14	0.4471	0.1513	25.28
	B	1	25.14	0.7346	0.2491	25.32
		2		0.7321	0.2477	25.28
		3		0.7356	0.2467	25.11
		4		0.7356	0.2467	25.11
		5		0.7356	0.2467	25.11
		6		0.7371	0.2457	25.00
		7		0.7371	0.2467	25.08
		8		0.7371	0.2462	25.04
		9		0.7371	0.2457	25.00
		10		0.7321	0.2447	25.05
		11		0.7396	0.2457	24.94
		12		0.7356	0.2452	25.00
		13		0.7371	0.2462	25.04
		14		0.7356	0.2462	25.08
		15		0.7346	0.2457	25.06
		16		0.7356	0.2462	25.08
		17		0.7321	0.2477	25.28
		Standard deviation 0.11;			Mean value	25.09
4	C	1	25.14	0.7273	0.2393	24.76
		2		0.7199	0.2379	24.76
		3		0.7224	0.2408	25.00
		4		0.7224	0.2383	24.80
		5		0.7273	0.2408	24.87
		6		0.7248	0.2408	24.94
		Standard deviation 0.099;			Mean value	24.85
4	D	1	25.14	0.8305	0.2826	25.39
		2		0.8280	0.2801	25.28
		3		0.8378	0.2801	25.06
		4		0.8256	0.2830	25.53
		5		0.8378	0.2826	25.22
		Standard deviation 0.18;			Mean value	25.29

Table 2 (cont'd.)

Riproducibility of the measure on the same disc or on various discs of the same sample.

Sample N.	Disc	Spectrum N.	Relative weight of gypsum %	Absolute absorbance of marble	Absolute absorbance of gypsum	Relative absorbance of gypsum %
1	A	1	6.25	0.7985	0.0580	6.77
		2		0.8059	0.0590	6.82
		3		0.8059	0.0590	6.82
		4		0.8034	0.0580	6.73
		5		0.8010	0.0580	6.75
		6		0.8034	0.0575	6.68
		7		0.8034	0.0575	6.68
		Standard deviation 0.058;			Mean value	6.75

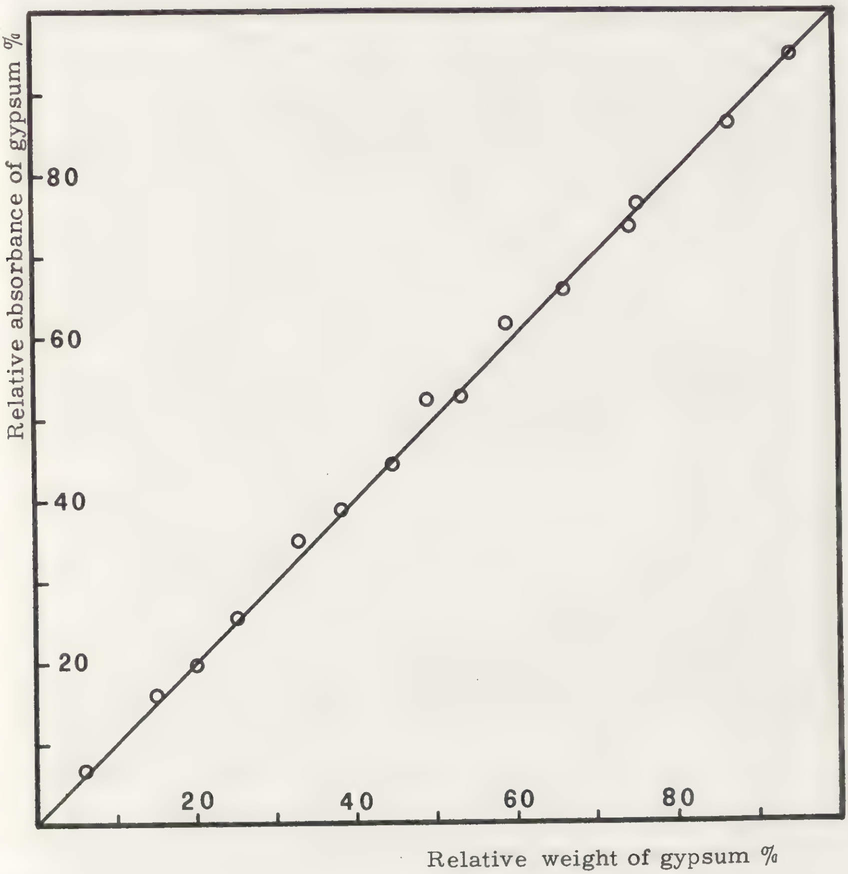

Fig. 4 - Gypsum in marble: Relation between relative weight and relative absorbance

Experimental

Gypsum used for this work was supplied from the Mineralogical Museum of the University of Florence. This product was ground in an agata mortar and the portion with dimensions lower than 100 micron used.

Calcium carbonate was a Carlo Erba product.

The mixtures, prepared by weight, were first ground, then mixed in an agata mortar and finally in a Perkin Elmer vibromill (using an agata capsule).

A small amount of the powdered sample (about 1 mg) was mixed with pure dry KBr powder (about 150 mg). An agata mortar and a pestle were used for grinding and mixing. The mixture was then pressed in an evacuable die at a pressure of 10 tons/cm^2 obtaining a disc with a 13 mm diameter.

The infrared spectrum of the sample was then recorded with a Perkin Elmer mod. 580, ratio recording, spectrophotometer.

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ANALYSIS OF ANCIENT MURAL PAINTINGS PIGMENTS FOR RESTORATION PURPOSES

A. Raggi, D. Cirulli, A. Breccia and L. Follo

SUMMARY

This paper briefly reports the results of an analytic study of the chemical composition of the paint layer of mural paintings in order to determine the pigments used to obtain certain colours and a morphological analysis by metallographic microscopy in order to ascertain the layer structure. This information is important for correct restoration and is also useful for the problem of dating. The qualitative chemical analysis of the pigments was performed with suitable analytic techniques.

INTRODUCTION

An important problem in the chemistry of conservation for the purpose of correctly restoring mural paintings, is the knowledge of the chemical composition of the pigments used by the artists and the study of the structure of the paint layer. This information is also useful for solving the problem of dating. These were the criteria for the present paper. Its scope is, in fact, the chemical identification of the pigments present in some Roman fresco fragments found in digs made a few years ago in the G. B. Martini Music Conservatory in Piazza Rossini, Bologna, and the study of the morphology of the paint layer by means of the metallographic microscope.

For the qualitative chemical analysis we used suitable analytic techniques [1], such as emission spectroscopy, which requires a minimum quantity of material and does not present the problem of dissolving the sample.

MATERIALS AND METHOD

The spectrographic analyses performed in order to determine the metals present, even as impurities, in the samples in question were made with an A.R.L. direct current arc emission spectrograph with grating. The electric arc discharge was provided by an A.R.L. mod. 4700 High -Precision Source.

Spectrographic measurements were carried out in the following experimental conditions:

slit : 20 μ

capacity : 60 μF

inductance : 300 mH

resistance : 100

discharge current : 4 amp

exposure time : 30 sec

Fig. 1 - Emission spectra of samples 1, 2, 3, 4 and 5 (from top to bottom). Each spectrum also shows the spectrum of iron.

Fig. 1 shows the spectra for samples 1, 2, 3, 4 and 5 (Table 2) from top to bottom. Each spectrum includes the spectrum for iron with the above parameters, but with a 10 sec exposure time.

The qualitative analysis was performed by measuring the wavelength of the spectral lines of the samples in question and comparing them with spectroscopic data for the various elements with the aid of appropriate tables [2]. For a reference spectrum or "spectral scale" we used the spectrum of iron, which covers a very large spectral range (2300 - 7000 A) and which, having a great number of closely grouped lines, permits easy interpolation for the measurement of the wavelengths of the spectral emission lines of the samples.

Qualitative analysis is possible, since the emission spectra are characteristic and of a complexity which permits the possibility of obtaining identical spectral lines from other substances to be excluded.

The semiquantitative measurements of the elements present in the samples were performed with a densitometer, an instrument which permits the optical density of spectral lines photographed on film to be measured.

Table 1 shows the results with the A.R.L. spectrograph in the above-mentioned conditions.

Table 1 - Results of spectroscopic measurements

	S A M P L E S				
ELEMENTS	I	2	3	4	5
Ca	+++	++	++	+++	+++
Si	+++	+	+++	+	+++
Fe	tr.	+++	=		-
Al	++	+	+	=	+
Cu	-	-	-	-	+++
Mn	=	++	-	=	=
K	tr.	tr.	tr.	tr.	
Pb			=	+	

Legend:

Intensity of the spectral line:

+++	very intense
++	intense
+	strong
=	average
-	weak
tr.	trace

All the elements of the various samples in Table 1 which were recorded by spectroscopy, whether in large quantities or in traces, were confirmed by other analytic methods (UV and VIS absorption spectrophotometry, spot-tests, etc.). Fig. 2 shows as an example the absorption spectrum for sample 3 in HCl solution using a Varian Techtron mod. 635 UV-VIS spectrophotometer.

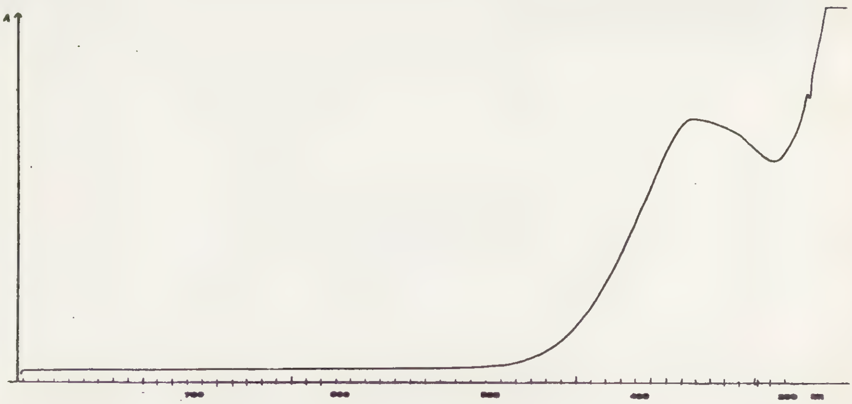

Fig. 2 - Absorption spectrum of a HCl solution of sample 3.

As can be seen, the spectrum is characterized by an absorption band whose maximum, contained between 350 and 370 mμ, is attributable to iron, in good agreement with the literature [3].

The presence of calcium, potassium and copper was demonstrated by flame spectra. All the other elements were confirmed by chemical identification tests. These tests permitted us to demonstrate also the presence of carbon in sample 1.

Table 2 summarizes the experimental results.

Table 2

Sample	Colour	Components
1	Black	Ca,Si,Al,Mn,Cu,C,Fe,K
2	Brick red	Fe,Ca,Mn,Si,Al,Cu,K
3	Yellow	Si,Ca,Al,Fe,Pb,Cu,Mn,K,Na
4	Red	Ca,Si,Pb,Al,Mn,Cu,K
5	Blue-green	Ca,Si,Cu,Al,Mn,Fe,K

DISCUSSION AND CONCLUSION

From the above experimental results the chemical composition of the paint layer of the analyzed samples can be deduced. It may be noted that in the five samples there are large quantities of calcium, silicon and aluminium and traces of potassium - components which indicate the presence of a calcareous-siliceous matrix ($CaCO_3$ - SiO_2 and alumino-silicates with potassium impurities).

Given this, some conclusions can be drawn from the experimental results taken as a whole and are in agreement with that reported by Selim Augusti [4].

The black colour of sample 1 can be attributed to the presence of carbon. The small quantities of manganese, copper and iron, which were also found in other samples,

are probably matrix impurities. This colour is probably that which was called "ATRAMENTUM" by the Romans.

The brick red colour of sample 2 can be attributed to the compound Fe_2O_3 or red ocher ("RUBRICA" or "SINOPIS") since the major component is iron.

The yellow colour of sample 3 indicates the presence of the chemical compound $Fe(OH)_3$ or yellow ocher ("SIL") mixed with PbO or litharge ("SPUMA ARGENTI"); in fact, in addition to iron, the principal component, there is also an appreciable quantity of lead.

The red colour of sample 4 can be attributed to the presence of the compound Pb_3O_4 or minium ("MINIUM") which constitutes one of the principal pigments used by the Pompeian mural painters; in this sample, in fact, lead is the only element present in any appreciable quantity.

The blue-green colour of sample 5, finally, may be attributed to the carbonates of copper: malachite ($CuCO_3 \cdot Cu(OH)_2$ and azurite ($2CuCO_3 \cdot Cu(OH_2)$), probably "armenium" or "caeruleum hispaniense".

With respect to the morphological study of the paint layers, the metallographic microscope was used (1).

The optical examination of cross sections of the samples in question, suitably incorporated in resins and smoothed and polished, permitted the identification of the following sequence of layers:

1) frescoed surface

2) intonaco

3) arriccio.

The paint layer of the frescoed surface seems to be a simple, non over-laid pigment. The intonaco is a compact formation, without internal layers and with coarse-grained agglomerates.

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(1) The microscopic observations were performed with a Metallux Microscope from Leitz at the Restoration Laboratory of the "Museo Civico Archeologico" of Bologna.

The figures show dark field photographs of the examined samples of Roman wall frescoes.

In conclusion, the analysis with emission spectroscopy and UV-VIS absorption spectrophotometry, combined with a series of morphological investigations with the microscope and microchemical investigations, showed that the examined fresco samples are composed of a layer of arriccio and one of intonaco on which the pigments were deposited in a calcareous-siliceous matrix. The pigments used to obtain the different colours proved to be components consistent with the literature [4].

On the basis of the information given, it may be deduced that the samples examined belong to a decoration made between the first and second century A.D. (1), probably by native craftsmen.

Fig. 3 - Dark field colour micro-photograph of sample 1 (magnification 6.5 x 10).

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(1) Early Roman frescoes were made with three layers of arriccio and three of intonaco.

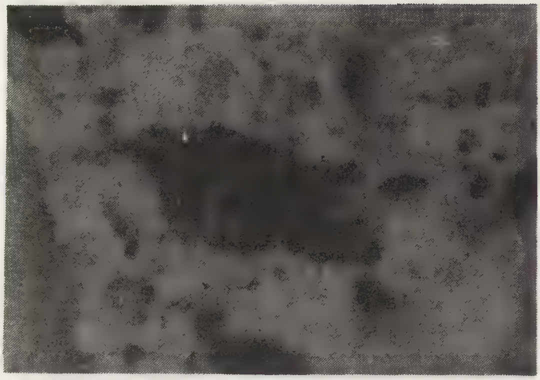

Fig. 4 - Dark field colour micro-photograph of sample 2 (magnification 11 x 10)

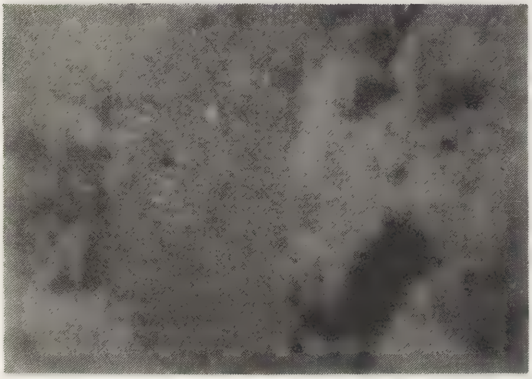

Fig.5 - Dark field colour micro-photograph of sample 3 (magnification 11 x 10)

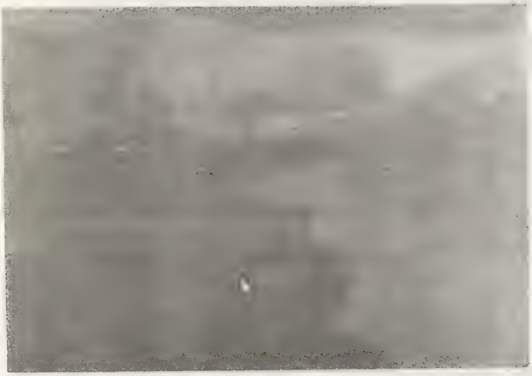

Fig. 6 - Dark field colour micro-photograph of sample 4
(magnification 11 x 10)

Fig. 7 - Dark field colour micro-photograph of sample 5
(magnification 11 x 10)

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INFRARED COLOUR FILMS AS AN AUXILIARY TOOL FOR THE INVESTIGATION OF PAINTINGS

M. Matteini, A. Moles and P. Tiano

ABSTRACT

The following is a report on research into the use of infrared color film as a means of obtaining further scientific information about paintings.
The condition of the tests are outlined and the results tabulated.
Three principal results are discussed : 1) the possibility of obtaining a sharper visualization of antique paintings -2) I. R. photografy as an auxiliary tool to be used in addition to U. V. techniques to distinguish retouches in paintings -3) the possible use of I. R. color film in obtaining analytical information about pigments. Further studies are now under execution to improve with microscopial techniques this third use.

INTRODUCTION

In medical, forestal, aerial photointerpretation and many other fields, researchers utilized the photografic records of radiation with different wave lenghts from those of visible light, to get special information. In the field of works of art also, photografic techniques in X-rays, U. V., and I. R., were often studied and used (1, 2). X-rays have penetrating properties higher than visible light. U. V. radiation is well known for its power to excite visible fluorescence. I. R. rays, on the other hand, are less scattered by cloudy thin layers, such as varnishes or dust, allowing a sharper visualization of under-layers.
Furthermore U. V. and I. R. radiation may be reflected by various materials in a different way, compared to that of visible light.
Several I. R. photografic applications were carried out to scientifically investigate works of art with the use of black and white films (3, 4). On the other hand, up to now little investigation has been reported with respect to I. R. color film, (5, 6) primarly most likely because these films have only been commercially available for a few years.
C. Olin and T. Carter in 1968-70 (7), Wehlte in Maltechnik 1970 published works in which they proposed the use of I. R. color films in the scientific investigation of works of art. On the same subject an unpublished work by Mairingen was presented in Madrid, 1972. These authors noted the important applicative properties of these photografic techniques in investigating painting materials.
Following these researches we used the commercially accessible

Kodak Ektachrome I. R. color film, which is similar to the Kodak Ektachrome I. R. Aereo film Type 8443 used by Olin et al.
In the present paper we report our preliminary investigation the object of which is to obtain further information about materials of worksof art, through the additional chromatic parameter.
With respect to visible light rendition, the modified chromatic rendition, " false color", allowed by I. R. color film, may produce important information about the different materials used in the works of art, pigments above all.

EXPERIMENTAL CONDITIONS

Film

A Kodak Ektachrome infrared 35 mm. daylight film was used. This film has three image layers sensitized to : green, red, and infrared; with a 900 millimicron infrared sensitivity limit (see fig. 1).

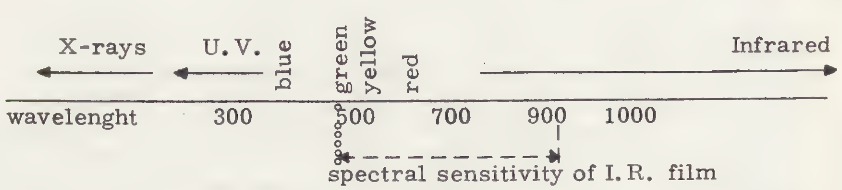

Fig. 1 - Electromagnetic spectrum of radiation (wave lenght in millimicron. °°°° Cut on of no. 12 filter).

Color formation of the film is shown in fig. 2.

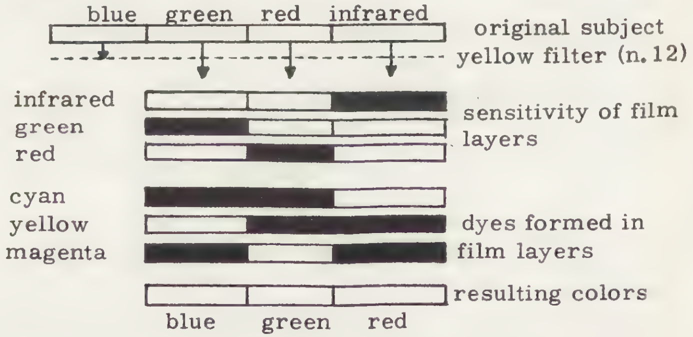

Fig. 2 - Color formation with I. R. Kodak Ektachrome film.
(from Kodak Publication NO n. 1)

Lighting

Lighting sources must contain infrared radiation. For indoor use electronic flash lighting is more suitable. Two electronic 500+500 watt power synchronized flashes were arranged as in fig. 3.

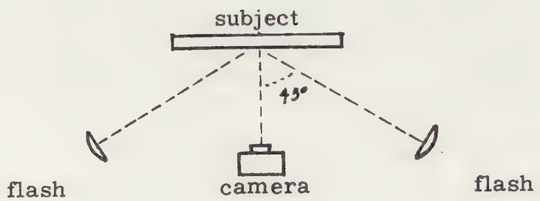

Fig. 3 - Arrangement of the photografic set-up.

Filters

In order to avoid blue radiation a gelatine Kodak Wratten n. 12 filter was held in front of the camera lens. A series of colour compensating filters (CC Blue, Magenta and Cyan series) were tested to equilibrate chromatic response in relation to the clearest differentiation of materials.
The best result was achievede coupling KW n. 12 with CC 50 Cyan filters.

Camera

Any 35 mm. camera my be used. No difference among various lenses was found.

Exposure condition

Exposure conditions, flash sources being used, depends only on diaphragm-setting which are obviously related to the distances between light sources and subject.
As a general rule we found that the best result may be obtained with the smaller diaphragm-settings.

Test materials

Several different subject were recorded by the I. R. colour film. In order to compare various pigments used in paintings, six 70x40 cm. panels with different grounds were prepared. Each panel was divided in four sectors each painted with a series of pigments in different binding media (table 1, 2 and 3).

Table 1 - Grounds of test panels

Panel	Ground
1	Gypsum + animal glue
2	Gypsum + animal glue / linseed oil emulsion
3	Gypsum / raw Sienna + animal glue
4	Gypsum / raw Sienna + animal glue / linseed oil
5	Calcium carbonate + animal glue
6	Gypsum + animal glue (first layer) Bole + fish glue (second layer)

Table 2 - Binding media
Whole egg - Yolk - Linseed oil - Egg/ oil emulsion

Table 3 - Pigments

Blue	Azurite, Lapislazuli, Ultramarine (artificial), Indigo, Smalt, Prussian blue, Cobalt blue, Cerulean blue.
Green	Malachite, Verdigris, Earth green, Chromium oxide green, Emerald green.
Yellow	Ochre yellow, Naples yellow, Chrome yellow, Cadmium yellow, Barium yellow.
Red	Vermillion, Venetian red, Lead red (minium), Cadmium red, Madder Lake, Crimson Lake, Dragon's blood.
White	Lead white, Zinc white, Titan white.
Black	Bone black, Vine black, Graphite.
Others	Cobalt violet, raw Sienna, burnt Sienna, raw Umber, Van Dyck brown, Bitumen, Gold, Silver.
Resins	Paraloid, Mastic and Dammar resins also were applied directly to the ground.

Six XII°, XIV° and XV° century panels paintings were also recorded.

RESULTS

Scarse chromatic variation appear to result for a pigment in different media.
Average "false color" rendition together with visible light colour was tabulated for each pigment as shown in table 4.

Table 4 - Chromatic infrared rendition of pigments

Pigment	Infrared "false colour" rendition
BLUE	
Azurite	deep blue
Lapislazuli	dark violet brown
Ultramarine (art.)	very dark blue
Indigo	very dark brown
Smalt	intense red
Prussian Blue	black
Cobalt blue	intense red
Cerulean blue	magenta
GREEN	
Malachite	blue
Verdigris	deep blue
Earth green	black blue
Cobalt green	magenta
Chromium ox. green	violet grey
Emerald green	blue
YELLOW	
Ochre yellow	light grey-green
Naples yellow	white
Chrome yellow	very light grey-green
Cadmium yellow	very light grey-green
Barium yellow	white
RED	
Vermillion	yellow ochre
Venetian red	brown-green
Lead red	brown-green
Cadmium red	intense yellow
Crimson Lake	orange
Madder Lake	dark brown
Dragon's blood	unmodified (dark red)
WHITE	
Lead white	unmodified (white)
Zinc white	unmodified (white)
Titanium white	unmodified (white)
Gypsum	unmodified (white)
Calcium carbonate	unmodified (white)
BLACK	
Bone black	unmodified (black)

Table 4 - continued

Pigment	infrared "false colour" rendition
Vine black	unmodified (black)
Graphite	black
OTHERS	
Cobalt violet	dark ochre
Raw Sienna	grey-green
Burnt Ochre	black
Raw Umber	black
Van Dyck brown	dark brown
Bitumen	brown
Gold	light blue-green
Silver	greenish
RESINS	
Paraloid	unmodified (transparent)
Mastic	unmodified (transparent)
Dammar	unmodified (transparent)

According to I.R. film colour rendition, a table was also drawn up in order to individualize the possible pigments corresponding to each "false colour" recorded (see table 5).

Table 5 - Probable pigments corresponding to each "false colour".

I.R. Colour	Pigments
Very dark blue	Ultramarine 'art.' - Green Earth.
Blue, different tones	Azurite - Malachite - Verdigris - Emerald green.
Greenish, different tones	Gold - Silver - Yellow Ochre - Chrome yellow - Raw Sienna - Venetian red.
Red, different tones	Cobalt blue - Smalt - Cerulean blue - Cobalt green.
Brown, different tones	Indigo - Lapislazuli - Van Dyck Brown - Bitumen - Madder Lake - Cobalt violet - Dragon's blood .
Violet-grey	Chromiu oxide green

Table 5 - continued

I.R. colour	Pigments
Yellow, different tones	Cadmium yellow - Vermilion - Red Lead - Cadmium red - Crimson Lake.
White	Lead white - Zinc white - Titanium white - Gypsum - Calcium carbonate - Naples yellow - Barium yellow.
Black	Bone black - Vine black - Graphite - Raw Umber - Prussian blue - Burnt ochre.

Result of I.R. images recorded from two of the six original panel paintings, are reported as an example (see table 6).

Table 6 - Colour changes from visible to I.R. colour in panel paintings.

Detail of painting	visible colour	I.R. colour rendition
<u>Panel A</u>		
Fleshtone	flesh colour	different blue-green tones
Trousers	red	yellow
Boots of S. Rocco	light brown	very light yellow
Sky	blue	blue
Mantle and heart of S. Ignazio	red	yellow
Mantle decoration of S. Ignazio	yellow	white
(Note : Blue retouches in the blue sky appear red)		
<u>Panel B</u>		
Various red details	red	yellow and orange
Blue details	blue	red
Wings of Angel	different blue green tones	some red some blue
(Note : Two different blue pigments present on S. Michele's feet are well differentiated. "False colour" maintains the blue of one pigment while converting the other to red.)		

Panel A - 'S. Rocco e S. Ignazio' by Raffaellino del Garbo - XV°cent.
Panel B - 'S. Michele Arcangelo' by Tuscan school of XIII° century.

Other subjects investigated were :

C) - Madonna with Child, by pseudo Maestro della Maddalena -XIII° century. (Three different overpaintings partially exposed)

D) - Madonna del Giglio, by Maestro Fiorentino - XV°-XVI° cent.

E) - Madonna with Child, by Maestro della Maddalena - XIII° cent.

F) - Tobia e i tre Arcangeli, by Botticini - XV° century.

In all these paintings, several retouches are well chromatically differentiated.

DISCUSSION

Results obtained appear to confirm our initial hypothesis about the differentiating properties of infrared colour film.
It is possible to point out some fundamental results according to this preliminary investigation.
1) In every case I. R. colour images allow a sharper visualization of the original painting. Two properties are related to this result :
a) the fact that infrared radiation tends to be less scattered by thin cloudy layers such as varnishes and dirty layers;
b) ancient yellowish varnishes appear in " false colour" as transparent colorless ones.
2) "false colour" rendition is able to reveal clearly some retouches according to the different nature of the pigment used. Infrared colour images must be compared with ultraviolet ones in order to get more complete information about painting condition preliminarly to restoration.
3) It is not yet possible at present time to attribute univocally a "false colour" to each pigment with this technique.
Pigment mixtures, differently thicknesses of pigment layers, varnishes and dirty layers are all factors which affect result interpretation.
Further investigations have then to be carried out in order to obtain more specific results.
Our laboratory is already carrying out tests to find analogous results by means of optical microscopy, directly on paint fragments in cross-sections.
In this way interferencies may be avoided and more rigorous conditions may result in a more univocal relation between rendition of I. R. "false colour" and visible colour of the pigment.

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L'APPORT DE LA REFLECTROGRAPHIE DANS L'INFRA-ROUGE A L'EXAMEN DE QUELQUES PEINTURES FLAMANDES DES XV^{e} ET XVI^{e} SIECLES

Catheline Périer-d'Ieteren

Résumé

Dans le cadre de travaux menés sur des peintures flamandes de la fin du XVe et du début du XVIe siècle l'étude du dessin sous-jacent a été largement facilitée par l'examen des panneaux en réflectographie dans l'infra-rouge. Les données fournies par les réflectogrammes sont venues compléter celles plus partielles apportées par la photographie dans l'infra-rouge et ont ainsi permis de formuler des hypothèses sur base de critères plus objectifs. La clarté de lecture des réflectogrammes a entre autres permis de progresser dans l'étude des dessins au poncif. Leur examen a mis en évidence une série de procédés employés par les peintres qui permettent d'aborder sous un jour nouveau les problèmes du travail d'atelier et des copies.

Le but de cette communication est de montrer par une série d'exemples choisis dans la peinture flamande de la fin du XVe et du début du XVIe siècle ce que l'examen des oeuvres en réflectographie dans l'infra-rouge a apporté comme données complémentaires à celles fournies par la photographie dans l'infra-rouge. Dans plusieurs cas l'information plus complète sur le dessin sous-jacent qui est donnée par la réflectographie dans l'infra-rouge a fait progresser les recherches en cours en aidant à confirmer une attribution incertaine, à caractériser la manière d'un artiste ou à définir la technique de dessin employée (1).

Examinons chacun de ces cas.

1) Le Maître de la jeunesse de St-Rombaut, huit tableaux illustrant la légende de St-Rombaut

Deux tableaux : le Sacre de St-Rombaut et le Départ de St-Rombaut conservés à la National Gallery de Dublin présentent de fortes analogies de style et de technique picturale avec six des panneaux illustrant la légende de St-Rombaut qui sont conservés dans la cathédrale de Malines (2). Le relevé de ces analogies permettait de penser que tous ces tableaux avaient été peints pour la série de Malines par un même maître anonyme brabançon que nous avons surnommé le Maître de la jeunesse de St-Rombaut (3). Seule la comparaison du dessin sous-jacent, tel qu'il avait été révélé par la photographie à l'infra-rouge, pouvait mettre en doute l'unicité de main. Le dessin sous-jacent du Départ de St-Rombaut semblait en effet être plus détaillé et d'une exécution plus rigoureuse que celui linéaire et très fragmentaire des autres panneaux du même

groupe stylistique. On notait un dessin de modelé assez élaboré dans les zones à ombrer des carnations et des vêtements, fait d'une suite de petites lignes serrées qui entourent les traits des visages tandis qu'elles longent les plis des drapés ou se croisent dans les ombres les plus profondes, et un dessin de mise en place qui cherche à situer dans l'espace les divers éléments de la composition. Comme il est fréquent dans les dessins préparatoires d'oeuvres narratives le dessin de situation n'est qu'esquissé et est sujet à des hésitations et à des reprises mais surtout de nombreux tracés sont abandonnés lors de l'exécution picturale, le peintre ne retenant que les éléments qui servent le mieux la narration.

On n'observait aucun dessin sous-jacent comparable sur les photographies à l'infra-rouge des panneaux de Malines. L'examen en réflectographie à l'infra-rouge par contre vint enrichir cette première vision du dessin en décelant en plus du dessin linéaire déjà relevé un dessin de modelé et de mise en place. Le dessin de modelé qui apparait dans les vêtements est d'une écriture serrée analogue à l'écriture qui caractérise le dessin du Départ de St-Rombaut tandis que le dessin de mise en place cherche à situer les éléments architecturaux de l'arrière plan de la composition et comme dans le Départ de St-Rombaut plusieurs formes sont ébauchées pour être ensuite abandonnées au stade de l'exécution picturale.

Ainsi les nouvelles plages de dessin qui ont été révélées par l'examen en réflectographie dans l'infra-rouge ont effacé le doute sur l'unicité de main que l'examen des seuls documents infra-rouge avait engendré. Les données neuves venaient confirmer l'attribution des deux tableaux de Dublin au maître qui peignit les six tableaux de la série de Malines en montrant que l'aspect plus élaboré du dessin du Départ de St-Rombaut n'est qu'un reflet décelable immédiatement, vu l'usure de la couche picturale, d'un style de dessin qui caractérise aussi les autres tableaux du même groupe stylistique.

Ce type de dessin préparatoire plus fouillé qu'il n'apparaissait à première vue concorde d'ailleurs mieux avec la technique encore assez élaborée du maître qui s'apparente davantage à la technique des Primitifs flamands qu'à celle des petits maîtres du tournant du siècle. Au contraire le caractère d'ébauche du dessin de mise en place soumis à des reprises rattache directement le Maître au courant narratif de son époque car les exigences du déroulement de l'histoire à raconter l'emportent sur le souci de perfection d'un dessin qui chez les Primitifs flamands annonce déjà l'exécution finale.

2) Le Maître de la Gilde de St Georges : tableaux illustrant la légende de St-Rombaut

Le Maître de la Gilde de St Georges est un peintre malinois de la fin du XVe siècle, dont le style et la technique sont très caracté-

ristiques des oeuvres narratives de l'époque (4).
Dans toutes ses compositions il ramène l'espace traditionnel à un plan optique purement pictural où l'image dictée par la narration est valorisée en tant que telle. Cette primauté de la narration a des conséquences directes sur la manière de travailler du maître de la Gilde de St Georges qui se livre à de constants remaniements sur des formes déjà entièrement peintes. Ces modifications sont clairement révélées par la réflectographie à l'infrarouge qui complète dans ce cas certaines informations déjà décelées sur les radiographies.
Une autre particularité du Maître de la Gilde de St Georges est l'importance qu'il attache aux portraits. Chaque personnage est parfaitement individualisé mais à l'intérieur d'un schéma type. Cette individualisation poussée des visages suggère un dessin préparatoire très étudié avant la mise en couleur. Or les photographies à l'infra-rouge ne révèlent aucun dessin sous-jacent. L'examen en réflectographie dans l'infra-rouge n'ayant décelé que quelques traits de mise en place des volumes généraux confirma ce qui paraissait être une anomalie.
Dès lors il était permis de supposer que le maître n'exécutait pas de dessin préparatoire sur le tableau même mais prenait pour modèles des esquisses qu'il avait réalisées sur papier. En outre on notait la même difficulté à préciser directement les formes dans la représentation des visages qui sont sujets, comme les autres éléments de la composition, à des variations tardives.
Ces multiples corrections apportées à des formes déjà peintes peuvent être dues à l'absence d'un dessin précis mais leur fréquence indique plutôt chez ce peintre que le moment pictural prime dans l'élaboration des formes. Il suit l'inspiration du moment et comme les formes et les relations spatiales qui les lient ne semblent se préciser qu'après une première mise en couleur il les corrige pour mieux les intégrer au déroulement narratif ou au portrait collectif.
Ainsi comme le Maître de la jeunesse de St-Rombaut, le Maître de la Gilde de St Georges s'intéresse plus à la valeur illustrative de l'histoire qu'il peint qu'à la perfection d'une composition préétablie avec rigueur et suivie lors de l'exécution picturale. Chez lui cependant les changements dans la mise en place des formes ne se fait pas par simple abandon de tracé du dessin préparatoire mais par remplacement d'une première version peinte par une seconde.

3) <u>Triptyque de l'Adoration des Mages, retable maniériste anversois</u>

Le panneau central du triptyque de l'Adoration des Mages conservé à l'église St-Sulpice de Diest présente un dessin au poncif, c'est-à-dire un dessin fait d'une succession de points obtenus par tamponnement d'une poudre colorée à travers les trous d'un calque (5).

Ce dessin a été révélé partiellement par la photographie dans l'infra-rouge mais n'a pu être étudié que grâce à l'examen en réflectographie dans l'infra-rouge.
Une fois caractérisé (6) il a été comparé à d'autres exemples connus de dessin au poncif comme celui de l'Adoration des Mages de G. David peinte d'après un original perdu de Van der Goes (7). Cette comparaison a fait apparaître la différence de conception qu'il y a entre une copie exécutée par un grand maître du XVe siècle et celle réalisée dans le cadre d'un travail d'atelier du début du XVIe siècle.
Les traits les plus significatifs du dessin au poncif de l'Adoration des Mages de Diest sont le manque de soin apporté à son exécution et les très nombreux tracés qui sont abandonnés ou modifiés lors de la phase picturale. Ces libertés que le peintre se réserve posent immédiatement le problème de la distribution du travail dans les ateliers, l'usage d'un poncif incitant à penser que l'artiste suit fidèlement les tracés qui lui sont fournis. Or dans le cas de l'Adoration des Mages de Diest non seulement ce n'est pas le cas mais encore le peintre met au point une série d'artifices pour masquer les négligences de tracé et les modifications. Il semble donc évident qu'une autre main ait exécuté le dessin au poncif sinon le peintre aurait sélectionné au départ les principaux tracés à suivre et surtout il aurait soigné davantage l'ensemble du travail préparatoire afin d'éviter de devoir recourir à des corrections.
Quelle est la raison des changements de forme que le peintre introduit ? La découverte d'une deuxième Adoration des Mages, conservée à New-York, similaire à celle de Diest apporte la réponse (8). En comparant les deux compositions on constate que la plupart des formes peintes de l'Adoration des Mages de New-York correspondent exactement aux formes dessinées de l'Adoration des Mages de Diest et non à leur exécution finale. Les deux Adorations des Mages relèvent donc d'un même modèle qui a été suivi fidèlement lors de l'exécution picturale dans l'Adoration des Mages de New-York mais qui a été modifié dans celle de Diest. L'examen de ces modifications montre toujours une recherche de simplification des formes ou du modelé. Ce type de préoccupation trahit l'oeuvre d'atelier puisque pour faciliter la production en série de peintures illustrant des thèmes à la mode on cherchait à simplifier chacune des phases de l'exécution depuis le dessin, d'où l'usage du poncif, jusqu'au rendu des modelés dont la structure devient plus sommaire. Cette attitude envers le dessin au poncif nous ramène ainsi au problème de la différence de conception que les peintres pouvaient avoir de la copie. Dans le cas d'oeuvres d'atelier du XVIe siècle, comme l'Adoration des Mages de Diest, il s'agissait de reprendre une composition existante pour épargner un long travail préparatoire. Le poncif était dès lors considéré comme un simple outil qui pouvait être manié par une autre main que celle du maître et être sujet à des modifi-

cations pour faciliter l'exécution picturale.
Dans le cas de l'Adoration des Mages de Gerard David au contraire le poncif est considéré comme un moyen nécessaire pour aider le maître à réaliser la copie exacte d'une composition reconnue comme idéale et dont il soignera alors l'exécution à la manière des Primitifs flamands.

En conclusion dans le cas de l'étude du dessin au poncif de l'Adoration des Mages de Diest la réflectographie à l'infra-rouge a été un auxiliaire précieux car seule la grande clarté de lecture des réflectogrammes a permis de caractériser le dessin, de relever les artifices employés par le peintre pour cacher les tracés inopportuns et de comparer les tracés du dessin avec les modifications apportées lors de l'exécution picturale.

4) La Sainte Famille d'après B. van Orley, Bruxelles, Musées Royaux des Beaux-Arts de Belgique

La photographie dans l'infra-rouge de la Sainte Famille de Bruxelles dévoilait un dessin au poncif. Comme ce tableau est une copie de la Sainte Famille peinte et signée par B. van Orley qui est conservée au Musée du Prado (9) il semblait intéressant, dans le cadre de l'étude des copies, de comparer les deux tableaux et d'approfondir l'examen du dessin sous-jacent de la version de Bruxelles à l'aide de la réflectographie dans l'infra-rouge.
La comparaison de la copie avec la version originale montre des changements de composition importants. Ainsi la position des jambes de l'Enfant qui se tourne vers sa mère et celle du genou de l'ange par rapport au coin de la table ont changé de même que la morphologie de la main gauche de Jésus et que les plis du tissu blanc du décolleté de la Vierge.
Il s'agissait donc de voir si ces changements dans la version de Bruxelles étaient dus à une interprétation libre des tracés au poncif lors de l'exécution picturale. Au contraire l'examen en réflectographie dans l'infra-rouge a révélé que le dessin au poncif a été suivi fidèlement au stade de l'exécution picturale et surtout qu'il dénote les mêmes différences d'avec la version originale.
On pouvait donc conclure que le poncif qui a servi à réaliser la Sainte Famille de Bruxelles n'a pas été réalisé sur la composition originale du Prado mais bien sur une version intermédiaire inconnue jusqu'ici.

L'étude de ces deux dessins au poncif ne constitue qu'un jalon vers la recherche systématique d'exemples de ce type souhaitée par J. Taubert qui est le premier à s'être penché sur ce procédé de dessin sans doute très usité dans la peinture flamande mais mal connu et à peine étudié. L'examen d'un plus grand nombre d'oeuvres d'atelier ou de copies au moyen de la réflectographie dans l'infra-rouge permettrait peut-être de rassembler les données nécessaires pour vérifier ce qui n'est actuellement que des hypo-

thèses et pour tenter de répondre à deux grandes questions : quelle est la fréquence de l'usage du poncif dans la peinture flamande et quelle est sa vraie destination ?

Conclusion générale

Les exemples d'examen de peinture où la réflectographie dans l'infra-rouge a été un auxiliaire indispensable pour les recherches de l'historien d'art sont déjà nombreux (10). C'est pourquoi je crois que parmi les méthodes physiques d'examen la place qu'occupe la réflectographie dans l'infra-rouge est essentielle car l'étude des données que cette méthode fournit permet d'aborder sous un jour nouveau l'étude du dessin sous-jacent qui en est encore à ses balbutiements. En effet jusqu'il y a peu les historiens d'art se sont toujours limités à un relevé des faits au départ d'informations partielles sans essayer d'interpréter ceux-ci en fonction du style propre à une époque, à un maître ou à un atelier, ce qui exigeait une documentation plus précise.
En donnant une information plus complète sur le dessin sous-jacent et en facilitant sa lecture la réflectographie dans l'infra-rouge seule peut aider à résoudre des problèmes aussi complexes que ceux des attributions ou encore du travail d'atelier où il faut pouvoir distinguer la part prise par le maître de celle prise par ses élèves (11).
Si on parvient à généraliser ce type d'examen on peut espérer rassembler petit à petit sur le plan international une bourse de documents suffisante pour assurer une étude scientifique des oeuvres d'art sur base de données plus objectives (12).

Notes et références

(1) Les examens des peintures en réflectographie dans l'infrarouge ont été exécutés dans le cadre de recherches d'histoire de l'art que nous avons menées à l'Institut royal du Patrimoine artistique. La lecture des documents a été réalisée en collaboration étroite avec Monsieur G. van de Voorde.

(2) Sacre de St-Rombaut et Départ de St-Rombaut, National Gallery, Dublin, inv. n° 1380 et 1381. Cathédrale St-Rombaut, Malines, panneaux 1 à 25, voir reproduction dans M. J. FRIEDLÄNDER, Early Netherlandish Painting, IV, Hugo van der Goes, Bruxelles, Leyden, 1969, p. 95 et 96.

(3) Voir étude des tableaux attribués à ce maître dans C. PERIER-D'IETEREN, Deux panneaux de la Légende de St Rombaut de Malines conservés à Dublin, dans Jaarboek van het Koninklijk Museum voor Schone Kunsten Antwerpen, 1976, p. 83 à 107.

(4) Voir étude sur ce maître dans C. PERIER-D'IETEREN, le Maître de la Gilde de St Georges, Catalogue critique de cinq des panneaux de la Légende de St Rombaut, dans Jaarboek van het Koninklijk Museum voor Schone Kunsten, Antwerpen, 1975, p. 153 à 201.

(5) J. TAUBERT, Pauspunkte in Tafelbildern des 15. und 16. Jahrhunderts, dans Bull. Inst. roy. Patr. art., XV, 1975, p. 387-401.

(6) Voir particularités du dessin au poncif de l'Adoration des Mages dans C. PERIER-D'IETEREN, Un triptyque maniériste anversois conservé à Diest - Contribution à l'étude du poncif et Problème des volets, p. 43 à 48, dans Bull. Inst. roy. Patr. art., XVI, 1976, p. 96 à 113.

(7) K. ARNDT, Gérard David "Anbetung der Könige" nach Hugo van der Goes, dans Münchner Jahrb. der bild. Kunst, XII, 1961, Münich, p. 153-170.

(8) Adoration des Mages de plus petit format (87 x 54 cm), Coll. Gerhard von Hessert à New-York.

(9) La Sainte Famille, chêne 84, 5 x 73, 5 cm, Musées royaux des Beaux-Arts de Belgique, inv. 359.

(10) Voir les études de R. van SCHOUTE et J. R. J. van ASPEREN de BOER, A note on the examination with infrared reflectography of some paintings of the groupe van der Weyden-Flémalle, dans Rapport de l'ICOM Comittee for Conservation - 4th Triennal Meeting, Venice 1975, 75/4/7, de J. R. J. van ASPEREN de BOER et A. K. WHEELOCK,

<u>Underdrawings in some paintings bij Cornelis Engebrechtsz</u>, dans <u>Oud-Holland</u>, 1973, p. 61-94, et de K. NICOLAUS, <u>Infrarotuntersuchung von Gemälden</u>, dans <u>Maltechnik-Restauro</u>, 2, April 1976, p. 73-101.

(11) Voir les études de M. A. FARIES, <u>Underdrawings in the workshop production of Jan van Scorel - A study with infrared reflectography</u>, dans <u>Nederlands Kunsthistorisch Jaarboek</u>, 1975, p. 89-228.

(12) Il faudrait envisager sur le plan international la publication d'une table des réflectogrammes existants ainsi qu'un système de prêt de documents pour consultation entre les chercheurs des institutions qui réalisent les examens de peinture en réflectographie dans l'infra-rouge.

THE EXAMINATION OF PAINTINGS USING HIGH RESOLUTION CONTACT MICRO RADIOGRAPHY

W.W. Percival-Prescott

The magnification of radiographs is usually limited by the coarse grain structure of industrial X-ray films. Methods have been found to give far higher resolution than can normally be obtained. These micro images at magnifications up to 200 x reveal characteristics of paint structures associated with the rheological properties of the paints. Micro crackle patterns of the various layers can be observed and a composite interpretation can be made of the paint layers as a whole.

The use of radiographs subsequently enlarged to show the finer structures was first described in 1913 by Pierre Goby who was able to make optically enlarged images of up to 17 x magnification. Goby was limited by the poor technical capabilities of the photographic films available at this time.

The British Standards Institute in their glossary of terms used in radiography (1955) described micro radiography in these terms: "Radiography of thin sections of material in such a way that the resulting image may be enlarged to reveal micro structure".

Advances were made using micro radiography in the 60s, particularly in the field of biology but it aroused little attention in the field of scientific examination of paintings and drawings. There were a number of reasons for this:

1. The radiographic equipment used in conservation laboratories and studios at this time was mostly unsuitable for this method.

2. Photographic materials capable of high resolution images could not be easily adapted to this end and were usually in the form of plates.

3. Techniques for micro copying were very limited.

4. The relevance of highly magnified radiographic images had not been appreciated. Micro radiography is essentially an exploratory technique for the examination of paint structures and is unconnected with the principal advantages arising from the normal radiography of paintings which can reveal changes of design and details of the artist's handling of the painting, as well as the losses of original paint. Micro radiographic information has little relevance to either of these aspects.

The purpose of this Paper is to show the advantages of using this basically simple technique by adapting modern, improved photographic materials and equipment. The method can produce rapid results; it is non-destructive as it calls for no sample being removed from the painting. Unlike the technique of the scanning electron microscope, it can offer a wide field of coverage at low to medium high magnification (e.g. 200 x) with very good "depth of field". This advantage allows the observer great opportunities for an accurate closely related interpretation of the evidence.

The equipment needed for the technique:

1. An X-ray unit with the capacity of long continuous exposures at low kV ratings (10-50kV).

2. A rubber base to support the painting, black polythene, thread, pressure sensitive tape and inflatable plastic bag.

3. Photographic film, Ilford lined film, Kodak high resolution film, Cat.No. 192/9074, 8" x 10" (20.3 x 25.4cm., 25 sheet boxes).

4. Black out facilities round the X-ray unit.

5. Micro copying camera equipment.

6. Dark room with washing and developing facilities, safe lights, etc.

7. Hand held microscope (described in an ICOM Paper, Venice 1975).

8. Ventilation equipment.

Micro radiograpny is most successful when soft X-rays are employed to produce images of low density structures, e.g. oil paintings, drawings and water-colours on paper. The degree of penetration through the picture is related to the density and atomic weight of the materials being penetrated and the excitation voltage of the X-ray tube. In practice most paintings will give an acceptable radiograph at kV levels of 20-40 kV. Drawings and watercolours require far lower kV levels ideally in the 6-10 kV range, but many X-ray tubes cannot operate at these levels. The tube used at the National Maritime Museum has a beryllium window 2mm thick which is able to transmit soft radiation at high intensities. Soft radiation is readily absorbed and scattered by the air and the unit has to be used in a position close to the picture if satisfactory micro radiographs are to be achieved. I have found that between 6"-10" from sample to unit is the optimum distance.

The duration of the X-ray exposure required to make a satisfactory micro radiograph may run to 200 mA minutes or even more in special circumstances. Few X-ray units are capable of such long running times but this time is essential to produce a satisfactory result.

The commonly available industrial and medical X-ray films are designed to give a rapid image and the finer grain X-ray films are still very much faster than process films such as Ilford Line which can produce much finer grain images. High resolution film is more than 20 times slower than the films previously referred to, and exposure factors must again be increased or the unit must be brought into much closer proximity to the picture. For example, a painting (Venetian 17th century unlined and without any backing material, with paint layers of low to medium thickness) will give a satisfactory image of about 4" diameter if the X-ray tube is placed at a distance of about 7" from the

painting with the unit operating at 40 kV using 5 mA. This produces a total exposure of 200 mA minutes, with an exposure time of 20 minutes.

Development of the X-ray film should be carried out visually with the aid of a safe light (IA or OC illumination). The image should be allowed to become as dark as possible while still giving a wide range of tone. To produce a dark image it may be necessary to increase the strength of the developer, e.g. as much as 50% undiluted DX80 developer may be required. It should be stressed that when the apparently dark X-ray image is copied the final tonality will be lighter. The principle applies to both low and high magnification ranges and must be observed if good final results are to be obtained.

To obtain micro radiographs capable of magnification of up to 200 x, the stability of the X-ray tube and even more important the close contact of the paint surface with the X-ray photographic film is essential. The X-ray head should be placed as far as possible from the sample to avoid geometrical penumbral effects, but in practice this distance is severely limited by air absorption attenuation.

The focal spot size of the tube should be as small as possible if high resolution is to be achieved. The samples illustrated in this Paper were made with a tube of 1.5mm square. Some tubes are now made with much smaller photospots and theoretically these should be capable of higher resolution.

One of the most difficult operations involved in this technique is to hold the painting in firm contact with the film for periods of up to 30 mins. The closer the contact, the higher will be the resolution of the image on the film. The steadier the X-ray head, the greater will be the apparent depth of field. It should be remembered that slight variations of film proximity will always be present caused by the uneveness of the paint layers. Lateral movements during exposure cannot always entirely be obviated but vertical movement can be greatly reduced by the use of soft inflated bags

placed between the X-ray head and the back of the painting. Taut polythene wrappings have been used to introduce pressure between the painting and the X-ray film. In most cases thick rubber mats placed below the picture or drawing seem to offer the best and most stable support, and protect the painting from any unnecessary pressure.

Stages of the operation:

1. Examine the painting to be radiographed and establish that it is sufficiently strong to be handled and that any areas of flaking are re-attached before examination.

2. In safe light conditions place the painting over the unwrapped line film with the emulsion side in contact with the paint surface.

3. Both painting and film should be placed face down over a large firm rubber mat, with a layer of melinex isolating the rubber from the picture.

4. Centre the X-ray tube over the area you wish to examine and where the X-ray film has been located. Raise the tube to the optimum position; this can be as much as 5' above the painting, and make the exposure.

5. Remove film and process using X-ray developers and visual development with the aid of a safe light.

6. Examine the radiograph with the aid of a hand held pillar microscope and select areas which appear to be of interest.

7. Locate these areas on the original painting and, in the case of a painting on a stretcher, stretch thread horizontally and vertically marking the exact location to be examined. Tape the thread to the back of the stretcher, and continue stretching on this side also. The painting is now ready for micro radiography.

8. In darkened conditions using the safe light place a sheet of high resolution film in position, using the threads as indicators. The film should be placed in immediate contact with the surface of the painting.

9. Lay the picture and film gently face down on the flat rubber sheet.

10. Lower the X-ray unit and centre the cone on the location of the crossed threads. Cut the threads and place an inflated bag between the outer lip of the cone and the back of the painting. Gentle pressure is necessary to keep the surface of the painting and film in close contact for the period of exposure.

11. Set the X-ray unit at the appropriate kV and mA and adjust the time setting mechanism. Expose the film.

12. Remove the high resolution film and develop, fix and wash. Visual development should always be made using a safe light and a dark image aimed at.

13. Place the micro-radiograph over a light box covering the film with a thin sheet of perspex to protect it. Scan the radiograph with the aid of a magnifier or a pillar microscope. Areas which have particular importance may then be cut out of the film and mounted for copying purposes. The methods of mounting must be chosen to suit the particular type of projection technique used. A wide range of photographic methods can be adapted to give prints from the radiograph with magnifications from low to high. The grain of the film determines the degree of magnification. Line films can be magnified up to 40 x; high resolution films up to 200 x.

Micro radiography has good potential and, should it become a regularly used technique in our laboratories and studios, there is little doubt that our knowledge of paintings and their physical structures would be greatly widened. Like every other comparative technique it should be considered as one method to be correlated with other sources of information.

Comparative data is now being collected from paintings of various periods using micro radiography, distinguishing technical characteristics of the paint structure of particular artists. Thin low-density supports like silk, paper and vellum are also being examined as well as watercolour, tempera and drawing materials. Cine films based on micro radiography can be used to illustrate patterns of rheological change and the kinetic aspects of painting materials.

Micro radiograph, life size, showing detail of saint, hands pressed together in prayer. Contact print from high resolution film radiograph. Venetian, 17th century painting, oil on canvas.

Microradiograph 180 x.
Detail enlarged from figure 1 showing layers of paint. The central area shows ground and priming layers. The final paint layers are to be seen on either side. The vehicular structure of these three layers differs greatly. Notice the Benard cell structure of the ground and priming layers and the vehicular structure of the porous paint layers.

CONTRIBUTION TO THE PHYSICO-CHEMICAL RESEARCH ON ANCIENT EGYPTIAN MATERIALS

Jiří Čejka, Eva Kaprálová, Zdeněk Urbanec and Eugen Strouhal

Abstract

Results of a study of materials from ancient Egypt including inorganic coatings (metallic and mineral), mineral filling and synthetic eyes of mummies deposited in Czechoslovak collections , ceramics from Nubian cemeteries formed in the 4th and 6th century A.D. at Wadi Qitna and Kalabsha-South, and a calcified myoma uteri found out at Sayala cemetery has been reported.

The examination of the enumerated materials has been realized in the Research Chemical Laboratory of the National Museum in Prague using physical and physico-chemical methods - emission spectroscopy , X-ray diffraction analysis, differential thermal analysis, infrared spectroscopy and chemical micro-analysis. For the treatment of analytical data of the Nubian ceramics, the cluster analysis has been used. To that purpose the Elliot 503 computer has been utilized. The resulting data became a basis for objective archaeological examination of the treated ceramics and further materials, and for the conservation treatment of materials under study.

I n t r o d u c t i o n

The Research Chemical Laboratory of the National Museum in Prague is intending to use (step by step) the modern physical and physico-chemical methods for the study of problems concerning protection and conservation of objects from museum collections including the scientific evaluation, classification and reassessment, in agreement with demands that are required on up-to-date museum chemical laboratories/ČEJKA 1973,1975a/. The complex of solved problems is very miscellaneous,e.g. the examination of metallic printing blocks/ČEJKA 1975b/,materials of tin and other metals, scientific reassessment of minerals/e.g.ČEJKA,URBANEC 1974a,b/ , the research of chemical composition and structure of human bones from archaeological study has been started which was directed to determination of sex, age, may be to dating. And last but not least problem is the treatment and conservation of lino-engraving blocks. In co-operation with museum conservators, a possibility to use various types of synthetic resins(paints,varnishes, dispersions, adhesives etc.)by the solution of protection and conservation problems of museum collection funds is investigated/ČEJKA 1976/.A great attention is paid to the research of various materials from ancient Egypt. In order to fulfil this task by the Research Chemical Laboratory of the National Museum in Prague, emission prism spectrographs ISP 22 and Q 24, grating spectrograph PGS-2, two X-ray diffraction instruments Mikrometa with the equipment for Debye-Scherrer powder methods,infrared spectrometers UR 10 and Perkin-Elmer 225, DTA Netzsch and Mettler Thermoanalyser 1 for thermal analyses, spectrophotometer Spekol, pH and fluoridometer OP108 and microscopes are available directly or in the cooperation with external research laboratories at present time. In perspective, we consider the application of neutron activation analysis,atomic absorption spectroscopy, X-ray fluorescence analysis and further methods in the cooperation with other scientific research laboratories. The application of modern physical ,physico-chemical and chemical methods for the study of protection and conservation and for scientific evaluation,classification,determination and reassessment of objects from museum collections is quite necessary and indispensable at the present time as e.g. was recently confirmed even by excellently equipped Rathgen Research Laboratory serving to museums in Berlin/RIEDERER 1976/.

In this contribution there are described results of a study dealing with some materials of ancient Egypt. The materials include inorganic coatings, fillings, synthetic eyes, found on the Egyptian mummies from Czecho-

slovak collections. There are given results of the examination of ceramics from Nubian cemeteries of the 4th and 6th century A.D.,Wadi Qitna and Kalabsha-South. Materials were discovered by an expedition of Charles University Egyptologic Institute in Prague and offered to National Museum. After all, a calcified myoma uteri was examined from the point of view of physical chemistry and structure, found on Nubian cemetery too (Sayala).

R e s u l t s a n d d i s c u s s i o n

Coatings and fillings from the mummies of ancient Egypt

Residues of metal sheets on mummified hands,microamounts of white or yellowish very thin coatings on head and neck, hands and within hair of mummies, greater amounts of filling for subcutaneous parts of the head and between thighs, and also synthetic eyes were found on Egyptian mummies by the anthropological study of Czechoslovak collections/STROUHAL,VYHNÁNEK-in press/. We used semiquantitative emission spectroscopy, X-ray diffraction analysis,thermal analysis,infrared spectroscopy and qualitative chemical microanalysis for deeper knowledge of these materials/ČEJKA 1974,ČEJKA et al. 1976/.

The metal coatings-folios of various substances were generally used in ancient Egypt to cover parts of mummified bodies/e.g.LUCAS,HARRIS 1962/.We examined the residues of the metal films found on mummified hands of two women. In both cases were determined residues of golden folios containing lower amounts of silver and addition of copper beside the bulk of gold.

At the mummified woman, we identified thénardite - sodium sulphate as a main component with admixture of anorthite,α-quartz,barite and glauberite, in the filling of the subcutaneous part of head beside an organic phase-probably resins that remain after mummification. The filling between thighs of the same mummy was of mortar nature too.It consists of calcium carbonate-structure type of calcite- as a main component and an admixture of α-quartz and diopside beside an organic phase of similar nature as in the subcutaneous part of head. Calcium carbonate originated presumably from calcium oxide-lime,by the absorption of atmospheric carbon dioxide. Both substances-sodium sulphate and calcium oxide-evidently of natural origin or prepared from natural raw materials were probably used as siccatives in view of their properties.

Microscopic coatings-films on the head of a mummified man are formed of α-quartz with admixtures of sodium calcium orthosilicates resp.aluminosilicates - ,

most probably from the group of plagioclases(types of albite,anorthite and oligoclase)- and of diopside. On the mummified hand of a male we found a coating of the same composition in the main. We may assume that micro-amounts of sulphate,carbonate,phosphate and chloride ions are present in both cases.The study of these extremely thin coatings were very difficult because of minimal samples we succeded to separate, in addition to it contaminated by an organic phase.

A whitish coating on the back and the palm of left hand belonging to a female mummy is formed mainly of calcium carbonate with an admixture of α-quartz,anhydrite and calcium aluminosilicates. In addition to it, the coating-first of all on the palm- contains a phase close to siderite - iron(II)carbonate.

Synthetic eyes fixed in the head of mummified man were prepared of calcium carbonate-calcite.In all nonmetallic materials studied was proved to be present α-quartz that is obviously characteristic for the examined region. The purpose of the use of fillings with thénardite-sodium sulphate, or calcium oxide-lime as siccatives appears to be generally unambiguous.Presumably the coating on the female hand of mummy has similar nature.The origin and purpose of thin microfilms of silicates on the head and hands of mummies remain an open question.We suppose that they may be residues of admixtures from natron which were mummified bodies put in.

Nubian ceramics from cemeteries of the 4th and 6th century A.D.

In the Ist part of our physical and physico-chemical research on ceramics from Czechoslovak expeditions into Nubia, we studied samples of ceramics from Nubian cemeteries founded in the 4th-6th centuries A.D.(burial mound cemeteries at Wadi Qitna and Kalabsha-South).

For the study of ceramics which have come from archaeological discoveries, a great variety of methods as emission spectroscopy, atomic absorption spectroscopy, X-ray fluorescence,neutron activation analysis, thermoluminescence are used/PERLMAN,ASARO 1969,1972, ARTZY 1976,KOSTIKAS,SIMOPOULOS 1976/.The classification of ceramics from the point of view of composition and origin of raw materials and technology used or the material dating, for which the computer technique was applied, has been the aim of this research.

A set of 102 samples from cemeteries at Wadi Qitna and Kalabsha-South(Egyptian Nubia) and 10 samples of contemporaneous Nubian ceramics was examined by semi-quantitative or quantitative optical emission spectroscopy and completed by X-ray diffraction analysis.

25 elements were considered in the spectral analysis using the concentration order: traces,0°0X,.... till X0°0%.The starting classification of ceramics was based upon archaeological considerations inferred from external characteristics which were compared with generally known macroscopic informations. We used the cluster analysis programmed by G.F.BONHAM-CARTER/1967/ and modified for Elliot 503 computer for the treatment of analytical data determined in our laboratory.A principle of cluster analysis is to " cluster " similar samples so that the formed pairs or groups are the nearest in qualitative or semiquantitative characters used. Each sample of ceramics was characterized by 130 characters. The results are presented in the form of dendrograms from which we can see the association levels of pairs and groups.

Twelve groups of ceramics follow from the archaeological considerations(A.-H. samples from cemeteries of the 4th-6th centuries A.D. at Wadi Qitna and Kalabsha-South):

A. Crocks of red-brown strong calcined smooth amphoras decorated by horizontal stripes and leaf-like patterns. They are considered to be products of Nubian workshops. (15 samples).

B. Crocks of brown amphoras with ochre paint, sometimes decorated by vine motives(13 samples).They might be imported to Nubia from Egypt or Syria.

C. Thin-walled cream coloured earthenware(15 samples), connected likely with Late Meroe workshops in the South Nubia.

D. Crocks of thin-walled hand-made ceramics decorated sometimes by engraving (30 samples) home made on that place.

E. Crocks of red-brown strong calcined dishes with a low stand. They were likely made in Nubian workshops. (6 samples).

F. Crocks of brown broad grooved amphoras and jars with a full conical tip made of soft material (3 samples). The origin is not determined.

G. The same as F, a hard material (2 samples).

H. Nonhomogeneous group (4 samples)

a) A red brown thick-walled dish made by the use of a potter´s wheel-may be from a Nubian workshop.

b) A dish with coarse walls made on potter´s wheel - may be from a Nubian workshop.

c) A thick-walled hand-made dish with an edge decorated by engraving- a local home-made ware.

d) A brick-red strong calcined amphora with narrow ochre slipped grooving-may be an Egyptian import.

I.-J. Tafa, the 1st-3rd centuries A.D., material for a comparison (6+4 samples). J -a part of ceramics furnace and a slag.

K. Naga el-Farik, the New Empire, a material comparison.

(4 samples).
L. Up-to-date ceramics, a compared material(10 samples)
a)Home-made ware
b)Imported ware of mass-production from Kena in Upper Egypt.

Even the starting archaeological informations were used for a preliminary classification of ceramic samples studied beside the data of spectral analysis and X-ray diffraction analysis. This procedure appears not to be proper. The point of view of the archaeologist might affect the results of cluster analysis.Therefore, we omitted the factors from archaeological classification in the final treatment and we applied only the data of spectroscopic and X-ray analyses.The groups I till L were not included into further treatment of the Ist research part because they were found to have no closer relation to the groups A till H i.e. the resulting treatment is dealt with 88 samples of the groups designated from A till H.This fact means(at the same time) in addition to it that no relationship has been proved between the present Nubian ceramics and the ceramics from Nubian cemeteries concerning the composition and the structure.

The main characteristic differences between individual groups will be presented including the samples that were rearranged after the cluster analysis. The X-ray diffraction analysis- which is considerably difficult to perform in multicomponent systems -corroborated the classification based on the spectral analysis what is in accord with the report of BIMSON/1969/.The results of the Ist part of our investigations on ceramics of ancient Egypt are published in the reports of the Research Chemical Laboratory of the National Museum in Prague /KAPRÁLOVÁ 1976, ČEJKA et al.1977/.We intend to present the results in the STROUHAL's monography on archaeological and anthropological studies of Nubian cemeteries at Wadi Qitna and Kalabsha-South from the 4th to 6th centuries A.D., as an excerpt(STROUHAL-in press).

The group of ceramics A is characterized by a relatively high content of calcium, nickel, copper, tungsten and beryllium and a low content of titanium,tin and aluminium. Twelve samples of this group from a homogeneous set to which one sample of the B group is loosely attached. Two samples of this group are transferred to the C group. The C group is formed from the 7 intrinsic samples and 2 samples originally of the B group.This set is distinguished for a relatively high content of chromium, tin, lead, beryllium and partly of zinc. The smaller remaining part of the group is connected only loosely.The B group formed from the 10 intristic samples and 3 samples originally of the A group is characterized by a high content of magnesium,titanium,sodium,nickel,calcium and

aluminium.The D group, the largest in the number of samples,has been divided into two subgroups,each containing 14 samples. The first one is characterized by a relatively high concentration of sodium,chromium, titanium and beryllium and low concentration of lead and tin,while the second one consists of the samples with higher concentration of calcium,tin and molybdenum, lower concentration of copper,manganese,vanadium, phosphorus, and partly of aluminium.Two samples of this group are closer with their composition to the I group of recent ceramics and to samples of G and H groups. Three samples from the E group form a loosely clustered set and the remaining three together with a sample of the H group and two samples of the C group are joined closer. For the latter set,there is typical an equal concentration of nickel,manganese,arsen and gallium ,high concentration of sodium,barium and lead (except one sample). The remaining groups which we studied in the Ist research part in detail, that is F,G and H groups are very similar from the point of view of spectral analysis and are defined by a relatively high content of sodium and an equal concentration of aluminium,nickel,manganese and beryllium.Of course,the other elements show a relatively great variability of concentration. One sample originally included in H group extremely differs from others with regard to the spectral properties.

The given statements that one or another element occurs at high or low concentration in some sample or group of samples show the relation to the mean concentration of the element in the sample.In spite of the impossibility to detect the very low traces of elements, i.e. values lower that 0,000X wt%, originated from the resolution of applied spectrographs,the resulting analysis justified the correlation of analytical data representing the concentrations of tens or units of wt% or lower. Characteristic factors were e.g. the differences of titanium,sodium and further elements content within separate groups. A treatment of such a great set of experimental data would be difficult and might be almost impossible without the use of computer technique. Graphical values showed that archaeological differentiation of A,B and D groups and to some extent even of C group has an intrinsic physico-chemical correlate. The D group (local hand-made ceramics)was divided into two subgroups, one of which included the earthen/ware from the grave-mounds No.1-112 at Wadi Qitna,and the other one from the grave-mounds No.163-388 at Wadi Qitna and No.4 at Kalabsha-South.The imported samples of Nubian or Egyptian-Syrian origin were also good differentiated from local ceramics. It is noteworthy to say that all aberrant crecks of the B group are found at Kalabsha' cemetery while the physico-chemically clustered crecks

of this group are from Wadi Qitna. The C group is considerably different from others. In addition to it, it shows and excellent physico-chemical differentiation. We can suggest that this modern and popular ware was produced by an equal way in various workshops using clay of different composition. The same holds even for E group.

It was not the purpose of this contribution to discuss the results of the study on ceramics in detail but to give brief information on the possibility how to use relatively easy available methods of physicochemical analysis for the improvement of archaeological research. At present, in the 2nd part of our scientific programme we are dealing with an examination of ceramics from the mastaba of princess Khekeretnebtey, the daughter of the king Jedkare Isese (the 5th dynasty) discovered at Abusir during an expedition of Czecheslovak Egyptologists in 1976. The detailed results of separate parts of our study on materials of Egypt will be presented step by step in Acta Musei Nationalis Pragae(Historia Naturalis).

A myoma uteri from a cemetery at Sayala

A myoma uteri was found by E.STROUHAL in the remaining material from a grave at the Sayala cemetery in Egyptian Nubia. The myoma was examined beside a paleopathologic study even by emission spectroscopy,X-ray diffraction,infrared spectroscopy,thermal analysis and simultaneously by qualitative chemical microanalysis. The myoma consisted of both inorganic and organic phases. The presence of organic phases which were not studied in detail, was recognized from an exothermic peak at about 325°C on the DTA curve of a sample from the myoma. The main inorganic component contains calcium and phosphorus, further sodium, magnesium, zinc and iron in low concentrations, and aluminium and silicon probably as an impurity. An inorganic phase of myoma has a hydroxylapatite type structure in which a part of phosphate ions was replaced for carbonate ions.Thus, it has structure of a bone in the main/WHITE 1974/.The structure of this calcified myoma uteri is identical with the structure of a bone from fossil skull found at Wadi Halfa cemetery, and of fossil bone myoma from Naga ed-Deir cemetery /STROUHAL et al. 1977/.

C o n c l u s i o n s

A combination of physical,physico-chemical and chemical eventually microchemical methods used by us for a study of inorganic materials of ancient Egypt from mummies, ceramics and myoma uteri has offered quite valuable analytical data which could be correlated each other and treated by a cluster analysis in the case of

ceramics. The results contribute considerably to deeper knowledge of the material studied and help to more reliable archaeological evaluation and classification of ceramics. Simultaneously, they iniciate a choise of proper protection and conservation methods of materials studied in our laboratory .

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THE QUALITY CRITERIUM AND THE OPTIMAL CONTRAST RATIO CALCULATION FOR X-RADIOGRAPHY OF PAINTING

A.I. Kosolapov

Abstract

The problem of selecting optimal parameters for X-radiography of paintings is considered in the paper. A criterium for the estimation of the best quality (optimal contrast ratio) of the radiograph of the layer of paint prepared with white lead is suggested. This method is based on the idea that the best quality of radiograph is achieved if the maximum number of brightness gradation is rendered within the linear part of the photo emulsion exposure logarithmic curve, the linear part of the curve corresponding to the blackening optical thickness values 0,5 - I,8.

Given are some experimental curves permitting the selection of the optimal voltage during radiography of the paint layer of a given thickness for X-ray films with different contrast coefficients.

A simple technique for the estimation of the effective thickness of the white lead layer on the picture is recommended.

The suggested method for selecting optimal conditions for X-radiography of painting allows the conditions for obtaining radiographs to be standardized. This is of great importance from the point of view of art criticism science when it is necessary to compare radiographs taken in different museum laboratories.

At present X-radiography is widely applied for the study of works of art, particularly paintings. Radiography is made use of in laboratories of most big museums. But though this method is widely used, the question of selecting the optimal parameters for radiography still remains quite problematic. For instance, some authors recommend I8-30 kv as the best tube anticathode voltage, others use higher voltage of 40-50 kv. Rather considerable are the differences in expositions, as the greatest thickness of the photo emulsion blackening is selected by most radiologists arbitrarily.

Due to the differences in the radiography conditions the comparison of radiographs taken in different laboratories is made difficult or impossible. Besides, part of the useful information about the work of art is lost on the radiograph taken incorrectly.

The lack of some definite technique for selecting optimal radiography conditions can be accounted for, in the first place, by the fact that there exists no criterium for determining the quality of the radiograph of the painting.

Here a quality criterium for the estimation of the painting radiographs is suggested and a simple experimental technique for selecting the optimal conditions for the given picture radiography is recommended.

Our experience at the State Hermitage and the analogy with photography suggest that the picture radiograph taken correctly must render the greatest possible number of the thickness gradations of the given white lead layer in the painting. Satisfactory rendering of the painting support texture (canvas, panel) is essential as well.

The criterium offered implies that for the given thickness of the paint layer to be radiographed the tube anticathode voltage must be selected so that during

exposition the least dense parts of the picture should be rendered by the blackening optical thickness, corresponding to the end of the linear part of the photo emulsion exposure logarithmic curve, while the denser parts – by the blackening optical thickness, corresponding to its beginning. Here it should be borne in mind that the greatest blackening thickness in which the gradations can be distinguished by the naked eye when the picture is examined on a negatoscope of standard brightness is $D \approx 2{,}0$. It follows that the maximum number of the distinguishable gradations of the thickness of the layer being radiographed is ~ 100, as the optical thicknesses differing less than by $\Delta D = 0{,}02$ are not discerned by the eye.

Now, to define the requirements of the criterium more concretely, it is requisite that the thickest parts of the white lead layer taken as basic for examination be rendered on the radiograph by the blackening optical thickness $D = 0{,}5$, which, approximately, corresponds to the beginning of the linear part of the exposure logarithmic curve for most types of X-ray films. It is also required that the thickest parts of the ground which does not contain any white lead should be rendered by the blackening thickness $D = 1{,}8$.

Judging from experience, the ground texture will be rendered on such a radiograph quite satisfactorily, that is, the thickness blackening interval $D = 2{,}0 - 1{,}8 = 0{,}2$ is quite sufficient for the texture to be rendered.

The conditions given may be written:

$$D(x,y,\lambda_0,T) = \bar{\gamma}\,\lg T \int_{\infty}^{\lambda_0} \varphi(\lambda,\lambda_0)\exp\cdot\left\{m(\lambda)x + n(\lambda)y\right\}\left[1-\exp\{-p(\lambda)d\}\right]d\lambda = 1{,}8 \qquad \text{(I)}$$

$$D(0,y,\lambda_0,T) = 0{,}5$$

where $D(x, y, \lambda_0, T)$ is the blackening optical thickness of the photo emulsion under the action of X-rays which passed through the ground of y thickness with the absorption coefficient $n(\lambda)$, and the white lead layer of x thickness with the absorption coefficient $m(\lambda)$ when emulsion absorption is $p(\lambda)$.

$\lambda_0(\mathring{A}) = 12{,}47 / U(kv)$ is the short wavelength border of the braking radiation spectrum of electrons which passed the electric field U; $\varphi(\lambda, \lambda_0)$ is the radiation spectral density function, T - the time-exposure, $\bar{\gamma}$ - the mean photo emulsion contrast coefficient.

The equations (I) solved, the bordering wave length λ_0, that is, the radiography voltage, as well as the exposition T may be determined, both of which providing the best quality of the picture radiograph.

Analytical solution (I), however, is limited, first of all due to the presence the absorption leaps of white lead and photo emulsion in the range of working voltages (Pb, L-line - I5,8 kv, Ag, K-line - 25,5 kv).

None the less, the optimal radiography voltage is simple to select experimentally on the assumption that the ground absorption does not essentially alter the appearance of the spectral radiation density function. In our work it was done with the help of an aluminium wedge with the "windows" of 50, I00, 200, 300 ... I600 μ. This wedge was photographed on a film with the voltage having various values in the I0-60 kv interval. The exposition was selected so that the optical blackening thickness of the parts of the photo emulsion not covered by the wedge should, after the development of the emulsion, be $D = 1{,}8$. The tube - film working distance was 0,8 m, which made possible to get the radiographs sufficiently uniform from the edge to the middle (the size of the

tube focus is 0,3X0,3 cm, the beam-divergence angle is 40°). Then, the thickness of the aluminium layer rendered on the radiograph by the blackening thickness D = 0,5 was determined for each radiography voltage. In this way were found optimal voltages, in terms of the criterium suggested, for the radiography of the aluminium layer of the desired thickness.

To obtain the optimal voltage curve evaluated for the white lead absorption, the wedge mentioned was photographed under various voltages together with the lead foil of known thickness. In this fashion there were found for all voltages the lead thicknesses values equivalent, in terms of their absorption, to the aluminium layers rendered optimally under these voltages.

In Table I are given white lead absorption coefficients calculated in terms of absorption additivity; the evaluation of white lead absorption for lead absorption presents no difficulties.

Fig. I presents radiography optimal voltage curves depending upon white lead layer thickness on the painting for films with the contrast coefficient γ = 3,5 (Kodak Microtex MC - 54) and γ = I,8 (RM - I when working without an intensifying screen). With films of other types the optimal voltages can be approximately obtained by contrast coefficient interpolation of curves given in Fig.I.

To determine the white lead layer thickness on the painting, it is advisable to make a test radiograph with the wedge placed on the part of the painting without white lead under the voltage not exeeding I5,8 kv. Here the white lead thickness $Z_{w.l.}$ sought for may be found from the ratio:

$$Z_{w.l.} = 0,IZ_{Al}. \qquad (2)$$

where Z_{Al} is the aluminium layer thickness rendered on

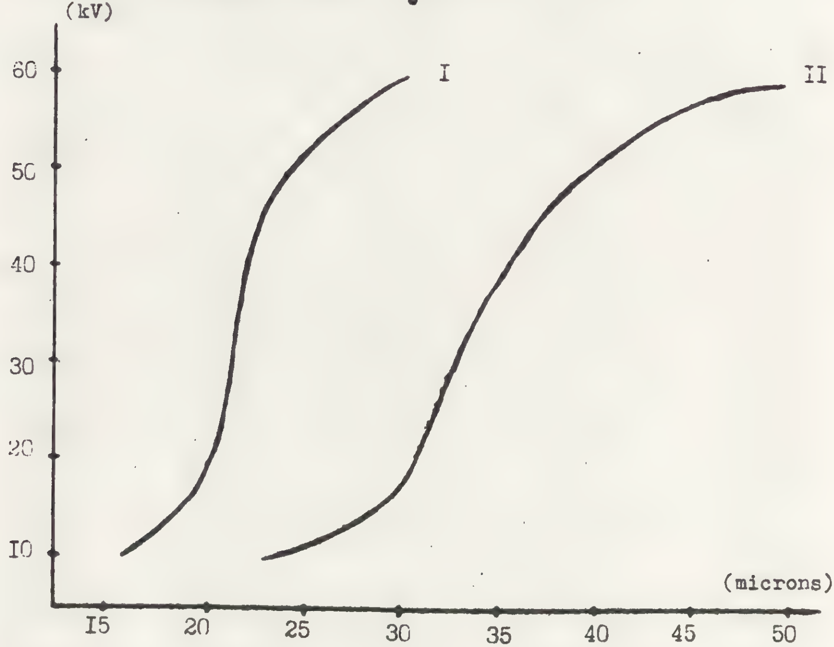
the radiograph by the same blackening thickness as the white lead layer to be examined.

The wedge and Fig. I makes it possible, when necessary, also to determine the thickness of the ground in the painting, but in this case the wedge is photographed separately of the painting under any voltage. Here the radiography voltage is immaterial as the gypsum or chalk grounds, as well as aluminium, have no absorption leaps in all the range of working voltages. The evaluation coefficient of the aluminium thickness for the gypsum or chalk ground equivalent in terms of absorption is $\sim$ I (see Table I) and does not depend upon voltage.

Table I. Coefficients of X-radiation absorbtion by some painting materials and by aluminium

Wave length (Å)	X-radiation absorption coefficients (cm^{-1})			
	White lead $2PbCO_3 \cdot Pb(OH)_2$	Gipsum $CaSO_4 \cdot 2H_2O$	Chalk $CaCO_3$	Aluminium Al
0,200	26,86	0,76	0,59	0,73
0,300	74,39	I,47	I,20	-
0,400	I73,67	3,I3	2,62	2,83
0,500	3II,I7	5,47	4,44	-
0,56I	406,I6	8,42	7,09	-
0,6I5	523,I2	II,02	9,34	9,59
0,7II	769,83	I6,84	I4,40	-
0,800	803,22	2I,I8	I7,04	I9,7I
0,900	-	29,76	23,78	-
I,000	424,39	38,69	3I,33	37,80
I,I00	643,96	52,60	43,05	-
I,200	699,04	65,46	52,42	64,80
I,300	890,53	8I,60	64,66	-
I,436	III3,98	I22,80	I03,72	I04,89
I,542	I328,I8	I47,50	I24,77	I29,87
I,659	I620,92	I80,30	I52,79	I72,77
I,790	I952,55	223,08	I87,46	2I7,0I
I,937	2367,22	277,03	23I,50	260,00

Fig.I Dependance of optimal voltage of X-radiography on white lead layer effective thickness.
I. X-ray film Kodak Microtex MC-54, $\bar{\gamma} = 3,5$
II.X-ray film RM-I (USSR), $\bar{\gamma} = I,8$



ENLARGED X-RAY PHOTOGRAPHS OF PAINTINGS MADE BY MEANS OF X-RAY UNIT WITH MICROFOCAL X-RAY TUBE BS-I

N.P. Altukhov and E.D. Altukhova

X-ray unit with microfocal X-ray tube BS that we have introduced into practice enables one to take not only contact X-ray photographs one to one but to produce X-ray photographs enlarged 2, 5, 7 and 10 times.

These enlarged X-ray photographs made it possible to reveal hardly noticeable details, structure of artists' strokes, structure and damages of painting support, biological attacks, painting of small scale and later overpaintings.

The enlarged X-ray photographs are more precise and of higher quality, have higher contrastness than one common X-ray photographs being enlarged by optical means.

X-ray unit with a microfocal tube BS-1 intended for decision of large sphere of tasks X-ray diagnostic, X-ray defectoscopy and also X-ray diffractoscopy and spectroscopy.

In X-ray defectoscopy this unit may be used to produce X-ray photographs of materials and items with thickness up to 10-12 mm of aluminium, 3-4 mm of steel or 2-3 mm of copper.

The unit makes it possible to perform defectoscopy with high resolution for light alloys, composites, plastics, polymers and so on.

In X-ray diffractology the unit enables to solve the most of standart problems of such analysis being especially prospective to produce X-ray Kossel diffractograms, to determine voltages by means of inverse survey, to work with microcells and so on.

In X-ray spectroscopy the unit may be used as X-ray generator for noncrystal, absorption and other analytical methods. The most important features of the method are:

- microfocal X-ray tube BS-I of very small focal size;
- electrostatic focusing - 100 u;
- extreemly small size and weight achieved by means of high frequency scheme of incandescence feeding, soled high voltage isolation, original adjusting construction for anode current of high voltage;

unit can be fed from 220v-alternating current or from 24v direct current.

For automation of X-ray photography processes the unit has:

- Voltage stabilizer preventing fluctuation of incadescence feeding under variations of net voltage in range $\pm$ 10%;

- Time-delay relay switching off high voltage after given time.

These features enable us to use the unit as portable working in nonstationary conditions, needing area in some times less than other. It is possible to record X-ray photographs of icon without need of their removal from iconostasis.

Voltage of the unit is smoothly adjustable in 0-45 kv range. Anode current is smoothly adjustable in 40-100 ua range. Minimal focal distance is 10 $\pm$ 2 mm. Angle of convergence of working beam is about 140^{o}. The unit consists of: high voltage block (weight 4 kg, size 350x100x165 mm)

- control desk (weight 35 kg, size 265x90x155mm)

High voltage block may be used in both table and foot variation. As a foot one uses a standart phototriod. The whole unit may be placed in a briefcase.

Photographing embroidery on altar cloth of XVIII century with usual stationary X-ray unit by means of contact method it is difficult to identify losses, repairs and later additions, by when X-ray photography is made with a unit with microfocal X-ray tube BS 1 enlarged shots clearly reveal texture of cloth, direction of thread strokes, mital thread and its braid, attachments of metal thread to support, thread directions and breach of these attachments. It is clearly

seen what kind of thread it is: spindle, span or some other kind.

Making enlarged X-ray photographs (3-7 times) we clearly see the structure of pavoloka (cloth under ground), grafyu (outline scratch by needle), and the details of technique is traced more distinctly than with usual contact X-ray photography. This unit has great possibility of using for X-ray photography of paintings and works of applied art.

Further works on studying of its possibilities are continued.

THE NEW METHOD OF THE ANCIENT FRESCOS RESEARCH BY RÖNTGENOEMISSIOGRAPHY

Igor Nikolaevitch Gilgendorf

It is more than ten years that in the Georgian State museum of arts the research and revealing by means of ultra-violet and infra-red rays of the ancient frescos inscription faded by different purpose is carried out. The researches gave a large scientific material, on the basis of which the scientists were able to introduce clarity into dates, to determine the names of historic persons, learn about different historic events.

In Ateni, temple of VII century, in 1957 was scarsely seen founder's inscription, which stated, that the temple was painted in 1080 by order of king Novolisimus and then after revealing by means of ultra-violet rays it cleared up, that inscription tells us only about partial restoration of the west wall and belongs to the border of XIII-XIV centuries and was carried out by order of Grigol, the son of Liparit Toreli. In the cave monastery complex David-Garedgi in the main temple Udabno the inscription has been read a new as well, which before was read as "this Lukian" and after revealing the new context was was found out "this sacristy with altar was painted". Besides this, in the same temple the ancient iconographie scene of painting, as scientists suppose, of the and of IX- beginning of X centuries, was distinctly revealed over which the is painting of XIII centurie.

On the whole number of other monnments, where this methods was used, a lot of information has been

received as well. But how ever valuable the received scientific data they are, when the research by means of ultra-violet and infra-red rays has place, they doesn't answer fully the raising questions.

That is why the farther work in this direction calls for enlargening of the means research methods, application of new methods, for one could receive information not only about autentic historic events, names, exact dates, but information about historic technology, connecting with the frescos techniques development in different epochs and other scientific information.

In connection with this new object was set - to carry out scientific experimental research of frescos by rentgenoemissiography method.

This method is based on a matter ability to emit from its surface the electrones under hard X-rays effect. In this case the inprint the film is effected by electrones, emissed from the matter atoms (paint pigment). The electrones emission from different matter is not equal. The higher on atomis weight of pigment is the stronger effect of electrones on the film. The more intensive emit the pigments, which contain lead, mercury, for example white lead, cinna bar, red lead and all the paints, which contain them.

By existing information from literature this method was not widely used because of its complicacy and limited posibilities for the technics on big easel paintings and absolutely excluded the research of frescos in templss.

To carry out the emissiography method of both, easel paintings and frescos we had to change the existing research techniques radically. In the first, we

had to chose the portable X-ray apparatur with tension in the tube not less than IOO kw and without water cooling system; in the second it was necessary to construct and make a special device, which allowed to carry out research of frescos in any place, in field conditions, in temples, in the day time.

After that we took the X-ray apparatur to the historic monuments of VII century - Ateni. The Ateni temple-one of most significant memorials of Middle age monumental painting of Georgia of the second half of XI century. For the first time we began experiments research of founder's inscription in ultra-violet and infra-red rays on this monument in I966, and decided to commence experiments in emissiography in it as well. In Ateni temple for many year already the constant research work is carryed out by scientists of the museum, in that outstanding memorial. And now to help art critics and restorers the new physical methods of research came.

In Ateni there is hundreds of inscriptions executed by quite different techniques. Most of them is difficult to read or are not visible, as they are much decoloared, crumbled or painted over with more late frescos. Most part of them we managed to reveal,and read. All the frescos as well as frescos inscriptions are executed on dry plaster, mainly with colours given by pounded colored soul, for whiting the chale was used, lame, and emissiography method and microchemical analysis showed - the artist used also white lead as well.

The experimental research of frescos and frescos inscriptions carried out in 27 places of the temple on different heights showed that inscriptions and murals mainly are painted with colours given by pounded coloured soul, which does not contain the pigment with

high atomic weight and did not produce any chiaroscuro image. The spectrographical analysis showed, that these paints contain following elements: sodium, aluminium, magnrsium, chrome etc. the atomic weight of which is no more then 65. Newertheless while painting the frescos the artist used white lead for painting the contours and in same cases used it for receiving one or another line for frescos finishing. All the images of saints magies and prophets, studied, showed a very interesting result: under each of them the scatche of the first drawing was revealed, in final version the artist sometimes changed it. On emissiographics there is distinctly visible the outlines of noses, eyes, chins, moths, beards, chicks painted as circle or in shape of turned up drop or oval: thoroughly traced out lips, which almost in all cases are very distinctly visible, inspite of it's lines are covered by layer of pait. In some cases the contour of the whole head and head gear is visible. On all of emissiographics you can trace the damages, various losses, the dab nature, which are not visible on common photoes.

Of great interest is the study of west apse, by complex method in ultra-violet, infra-red rays and emissiography, on which founder's inscription tells, that: "... this west wall was pictured..." In a result of tese studies the earlier conclusions of scientists about restoration of the west apse frescos were confirmed. All the plaster in Ateni temple, more exactly its surface, is brightly luminescening at close ultra-violet rays, at the same time the frescos and inscriptions do not luminiscening at all, but on the west apse the frescos colours are quite brightly luminiscening and this distinctly revealing the dif-

ference between the original parts of frescos and restored ones, restoration, as we know, had taken place on the XIII-XIV centuries border.

Some frescos of XIV were studied in Tsalendzihi temple, where this method did not produce the chiarosenro images. In the museum there is a large collection of frescos fragments of different size, removed with plaster from walls of many temples. We collect some 30 fragments which belong to XI-XVI centuries, all of the fragments were undergone the emissiography method and some of them were additionally studied in infra-red and ultra-violet rays. Approximately half of them did not produce the chiarosenro images for the absence of pigment with a sufficient high atomic weight. The other produced very interesting chiarosenro images of drawings, dabs and full contour of the whole composition. Especially interesting emissiographicks were taken from altar bar of XVI century in David Garedji monastery badly damaged and covered with dirt compositions of "Cristmas","Praymy wives", "Six-winge Seraphin" on which no details are discernable and part of other fragments were examined by complex method. In result a very interesting received, which allowed to see chiarosenro of the E.A.Archarova's portray by B.Tropinin on the canvas under the paint layer the earlier picture was revealed - still portray of a lady. The emissiography taken from the same portray solved all the problems and allowed to make necessary conclusions.

The microchemical analysis of frescos paints which produced the emissigraphy effect, showed in all cases the presence of lead.

The complex research method helps to determine not only damages in paint layers and the following restora-

tion colours, but the earlier paintings and an artist painting manner. These data will rended a great help in attribution, except of this, for all experts, working in the field of restoration and research of frescos and easel paintings these researches are especially great interest and could be used in their scientific work.

A NEW METHOD OF INVESTIGATING STRESSED STATE OF ARTISTIC WORKS IN RESTORATION AND CONSERVATION PRACTICE

L.A. Kuzmitch

Ascertainment of stressed state of a multiphase system - a painting on various foundations under conditions of constant temperature drops and ambient air humidity helps to bring about the solution of a package of problems involved in securing longevity of articles of artistic value.

In the majority of efforts related to long-term preservation of art objects investigations of mechanical-and-physical properties are made use of to assess the quality of a material and the method of its treatment for restoration and conservation purposes. These factors are, no doubt, highly important and fundamental research cannot do without them. But this is not enough, though. Interrelationship and compatibility of materials should be elucidated which are based on such physical phenomena as agglutination, the value of internal stresses and their reaction to certain environmental conditions. Gas permeability of a material is increased, its strength and longevity are reduced under the influence of internal stresses; this gives evidence about a necessity of a comprehensive and profound investigation of internal stresses occurring in various artistic objects, of their rôle in building-up of mechanical-and-physical properties of complicated systems - works of art and their long-term preservation.

Assessment of these parameters is hindered not only in investigations of painting materials but also

of other, especially, non-transparent systems, for quantitative methods of deformation measurement providing full information about the state of an object as a whole and its separate fragments practically do not exist.

We have suggested a method of wire strain measurement to ascertain stressed state of materials used in objects of artistic value. This method provides information about simultaneous deformation of various fragments avoiding destruction of the work of art. Resistance sensors mounted during an object's investigation relay the value of stress changes accurring in it to a recording instrument converting an electric signal into a value of deformation. Measurement accuracy is $1 \cdot 10^{-5}$ per unit value.

Thanks to the application of this method the following information was obtained pertaining to:

- alteration of paint layer properties by fixing compounds in the process of painting restoration;
- a new composition of restoration ground proportioned to be filled in places of missing painting fragments of various sizes on various grounds;
- stressed state of flax canvas in the process of painting;
- agglutination of patches used in fixing ruptures. Attempts to distinguish correlative dependences between the results of tests deploying the new method and the commonly used procedure have emphasized that the data obtained in the first case exceed those gained with the help of other methods by 15%;

- reaction of works of art to ambient air humidity drops. It is shown that the nature of influence of damaging factors on test samples, ascertained by the new method, is identical to the visually observed actual destruction process in works of art;
- only this method alone can help carry out investigations in choosing methods to conserve valuable objects of art, and it is applied in the efforts now underway to investigate methods of conserving paintings on fibrous foundations.

The research efforts covering interrelation of flax with ambient air humidity drops will be featured in some greater detail. Interrelation lofween canvas and humid air is based on adsorption phenomenon and has not been investigated in the field of conservation of museum objects up to now. Very few of oddly collected empirical materials exist. Qualitative deliberations of E.V.Kudryavtsev in his book on restoration techniques become, therefore, quite explicable: "Influenced by an increase in humidity the canvas, due to its hygroscopicity, gets damp and loose (at times, depending on a particular fibre property the opposite might happen)".

The whole thing is explained by the absence of elaborated methods of quantitative and theoretical investigation, while ever-increasing requirements of practice, which being used as guidelines could secure complete conservation of artistic objects, dictate the necessity of exactly a quantitative approach.

It is several decades already, therefore, since the research into the effects of humid ambient air on painting materials has entered the agenda. But so far the problem remains unsolved.

At present, research efforts have been carried out in the Department of Conservation Methods of WCNILKR to ascertain the effect of ambient humidity on flax canvas making use of an experiment. To this end, samples of flax canvas (Art. 09110 and 09144) were placed in side a chamber for 40 minutes at an 85% relative humidity of ambient air, i.e. exceeding normal humidity by 30% and above. Linear changes in canvases, that is their deformation, were measured under these conditions. After such treatment samples were placed inside an air dryer for 24 hours at a 45% relative humidity of ambient air. Deformation of flax canvas samples was also registed in this case. The action cycle was, then, repeated three times.

Diagrams 1 and 2 clearly show deformation of flax canvas samples (Art. 09110 and 09144) by triple treatment enumerated accordingly. As it is shown on the diagrams canvas deformation changes every time the factor is applied, i.e. increasing, though the strain force is constant. When the factor is applied for the second time (Diagram 1) the sample on foundation is also deformed, although the value of deformation is somewhat larger as compared with the magnitude of deformation during the first application. The difference becomes noticeable after 10 minutes of factor application - moist air. During the third application the canvas deformation is even greater and its magnitude reaches 170 per unit value. The canvas is, therefore, changed with every new application of moist air and this accounts for an increase in its deformation. Changes in deformation of canvas samples (Art. 09144) when the factor is applied and withrawn are absolutely identical to those mentioned above (Diagram 2). If Diagrams 1 and 2 are compared it may be also noted

that the drying process following every factor application slows down a bit; i.e. it takes more time. Thus, it takes 50 minutes to dry canvas 09110 after the first factor application while it takes twice as much after the third time. It is characteristic of canvas 09144; the drying period is 50, 60 and 140 minutes in this case. A deformation change seems to depend on "washing-out" of water-repellent component parts of flax fibre by moist air, and this effect is identical to wet treatment of cloth investigated by experts of the Ivanovo Scientific Research Institute of Cotton Industry. They have revealed a dependency: a sharp decrease is noted in the content of protein, pectinic and tallow waxes on the fibre during sizing and boiling. As a result of such treatment water-repellent properties of cloth are sharply reduced: cloth water-absorption is increased from 11.5 to 159, water-resistance and wettability of cloth drops to zero. On this basis it may be indicated that canvas treatment at an 85% relative humidity for 40 minutes equals a moisture impact. How many "impacts" of this sort have to be endured by paintings during their "life" time! One can hardly count them.

Paintings kept in premises with a constant moisture reserve are put in the worst conditions. Moisture effects every one of the layers: foundation, ground, paint layer, varnish coating. It is characteristic that various moisture effects are interwoven and maintain causal relationship with each other. Thus, for example, moisture contained in a canvas makes salts migrate in the foundation causing, in its turn, weakening of the adherence between separate layers and leading to destruction of physical structure of materials. Being hygroscopic substances they contribute

to development of chemical processes and micro-organisms.

After such an investigation, when it is ascertained that every effect of moist air causes unavoidable danges in a canvas special attention has to be paid to observing regulations of conservation and transportation of paintings, for it is in the presence of moisture that destructive processes start or become active.

USING OF ELECTRON X-RAY PHOTOGRAPHY FOR EXAMINATION OF PAINTINGS

L.A. Museus and V.G. Krasko

One is frequently faced with technical difficulties while undertaking radiographic examination of art pieces directly at museum displays or out in the field. This is due to the fact that processing of every radiogram requires much time and special dark rooms. Besides, X-ray films and chemical agents involved are both costly and deficient. Thus, operative producing and visual exposition of image patterns are often hampered and, at times, become entirely impossible.

The search for a faster and cheaper method of obtaining X-ray image patterns has come up with electrography or xerography. Its basic features are outlined below.

Radiography is applied in an ordinary way by means of a standard X-ray unit but instead of an X-ray film a special plate placed in a light-tight holder is exposed. The metal plate is covered with semiconductor coating (selenic as a rule) which is photoconductive and charged in the dark to high potential. The resistance of the photoconductive coating may be varied subject to ray intensity. A latent electrostatic image, thus, takes shape on the plate. Its development requires fine-grained electrized powder to be settled down on the surface of the plate. As soon as exposure is over the powdered image is transferred to ordinary notepaper and fixed. After that the image pattern is ready for examination under normal lighting conditions.

To evaluate the above method experimentally a

standard portable X-ray apparatus and ERGA-MP field medical electroradiographic apparatus consisting of three interrelated units were suggested. The first subunit is designed to charge the selenic plate and transfer images from it to paper. The developing unit is employed to visualize latent electrostatic images of the plate while the fixing unit produces image patterus fixed on paper in acetone and toluene vapours. The weight of all these small-sized units is 50 kilos. They are supposed to be packed in special boxes for transportation purposes. Selenic plates are stored separately in a special heat-insulating container.

Electrographic picture contrast is basically determined by the choice of plate charging and development potentials and depends on particular works of art under examination and problems to pursue.

Resolution is mainly determined by dispersability of developing powder and practically reaches the level of 10-15 p.min/mm.

The present-day state of technological development makes electroradiograms quite comparable in contrast and resolution with ordinary radiograms. The attached series of patterns obtained under various electric conditions while examining a variety of canvas and panel paintings proved that conclusion.

The advantages of electrography could be, thus, summorized as follows:

(1) dark room requirements are withdrawn;
(2) total time of producing a ready image pattern excluding exposure time is reduced to three minutes maximum while radiographic processing takes 1 to 4 hours per film;
(3) from an economic point of view electroradiography is ten times cheaper due to valuable

silver saving;

(4) careful handling of one selenic plate contributes to obtaining of about one thousand exposures before its final replacement;

(5) processing requires no chemical agents apart from acetone;

(6) both negative and positive image patterns can be obtained depenting on charge potential;

(7) a possibility of accentuating image profiles using marginal effects under certain electric conditions commands great interest.

The are also some limitations that can be expected to encounter in application of the given method:

(1) inadequate mechanical strength of the photosensitive coating requires gentle handling of the plate;

(2) climatic sensitivity of the method requires certain environmental conditions (permissible temperature of +5° - +35° Centigrade and relative humidity of 65 per cent maximum);

(3) development of the preceding image pattern left on the plate as a result of its long, multiple processing.

The last two negative points, though, are unessential in radiographic examination of paintings since in this case soft radiation and minimum exposures are applied.

The above analysis puts forward a suggestion as to ways in which electrography could be well employed for obtaining image patterns of paintings, that is, when there is a strong time limit factor or unfavorable conditions.

Physical possibilities of such applications have not yet been examined fully and are worthy of thorough consideration by research workers.

ZEBRA-STRIPE DISPLAY OF PAINTING STEREO-RADIOGRAMS

L.A. Museus and N.A. Valus

The method of large basis stereoradiography, i.e. at narrow angles of X-ray tube slope over the painting surface during exposure has been known for a long time in museum practices. Stereoradiograms of paintings and works of applied art contain much greater information about three - dimensional structure of objects than usual plane surface ones. Unfortunately, the efforts of a researcher or restorer in dealing with such radiograms are hindered by the necessity of deploying special stereoscopes. Designing and manufacturing of such stereoscopes offer certain challenges.

The method of reproducing stereoscopic images, being offered hereby, by making use of raster films and screens introduces a way of visualizing three - dimensional images without a stereoscope which opens broad horizons for widespread deployment of stereoradiography in museum practice. Besides, it also offers an additional physical opportunity to "look over" a detail of the researcher's object examining it at various angles of approach. It is most important when the object's fragment engaging our attention is of complex form or is overlapped with another one (brush strokes, alien insertions, hollow cavities, etc.).

The principle of producing an elementary raster stereoradiogram is as follows (Fig. 1).

At first, a painting is radiographed through a special metal gauze (X-ray raster 1) on an X-ray film (3). A radiogram is made several times on one film at different positions of the instrument's tube. The tu-

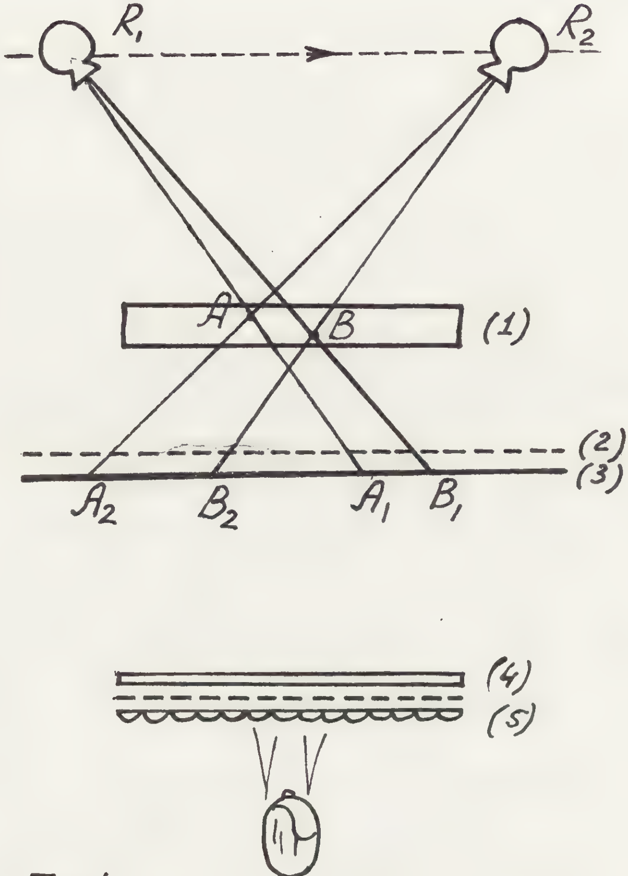


Fig 1.

be is shifted from one extreme position to another by moving the instrument alongside the raster plane but across its scanning lines with the image being split up into this vertical strips the width of which corresponds to the width of the raster set of lines. The shadow cast by the picture's point "A" in such exposure is fixed in section "A_1A_2" of the film while the shadow made by point "B" is fixed in section "B_1B_2". After exposure the film is developed in a usual way. The obtained raster roentgenogram (4) is then matched with an examination lens raster (5) and is illuminated by light thrown from the raster's side. An optical examination raster (5) is a transparent lens raster film or plate, cylindrical lens elements of which should have the same repetition period as a display X-ray raster's (1) while focuses of lenses coincide with the radiogram film surface (3). With such an arrangement an observer being on the raster's side would see a space virtual image of a picture's element behind it. This stereo image differs from a usual one and looks more like a hologram for it could be scrutinized from various positions at various angles of approach. If the distance from the plate to the examination raster is made greater than the distance to the display raster the depth of image can be further expanded. By way of the so-called reversal of radiogram a space image can be turned from the virtual space "beyond the screen" to the actual space "before the screen", making it accessible to direct measurement by instruments.

The first effort we attempted in experimental testing and assessing possibilities of this method consisted in the following.

Since manufacturing of a thin X-ray raster with a fine pitch is rather complicated ordinary radiographic stereopairs of different works of art were produced with a large operational basis to begin with. Stereo effect of obtained images was verified by an ordinary stereonegatscope. Both radiograms were later projected through a lens-raster screen and scrutinized having a usual source to produce light. Samples of such stereoradiograms are to be demonstrated while the report is made.

NEW METHOD OF THE ENVIRONMENTAL AND INNER RADIATIONS MEASUREMENT FOR THERMOLUMINESCENCE DATING

S. Ghini and A. Breccia

The used basic method of thermoluminescence dating of pottery is derived from Zimmermann (1) and known as "fine-grain technique".

The terra-cotta sample is powdered by compression and the fine grains of around 1-8 microns are separated by sedimentation in acetone media.

After drying the grains are lodged over aluminioum dishes of 5 mm diameter and 0.3 mm thickness. For each sample and each measurement 10 dishes are prepared.

In order to detect the TL emissions the dishes are exposed to different increasing doses of α radiations.

The measurement of the inner and environmental annual radiation dose is different than Zimmermann' one.

The comparative sensitive sample is a TL powder dosimeter (CaF_2) of the same greitness and the same quantity of the terra-cotta or pottery samples.

The CaF_2 fine grains is carefully mixed with the pottery powder under examination and all the mixture is deeply compressed together.

After a few months, four-six depending from the environmental radioactivity, the tablet is disgregated, the CaF_2 grains separated and the α , β , and γ activity of the sample measured.

In order to measure the ratio of the alfa radiations to the total radiactivity the dosimeter grains are lodged on the Aluminium

(1) Zimmermann S.: Archaemotry 13,1 (1971) 29-52.

dishes and covered by a known thikness of pottery powder. Part of the samples is shielded by an aluminium foil to stop the α radiation and part remains without shilding.

The different measures of radioactivity give the α ratio.

In similar matter the measure of environmental β and γ radiations is made; in this case the CaF_2 dosimeter is protected from alfa rays and buried in the same place and at the same depth of the discovered pottery. The α rays don't interfere the inner part of the pottery useful for the TL measurement.

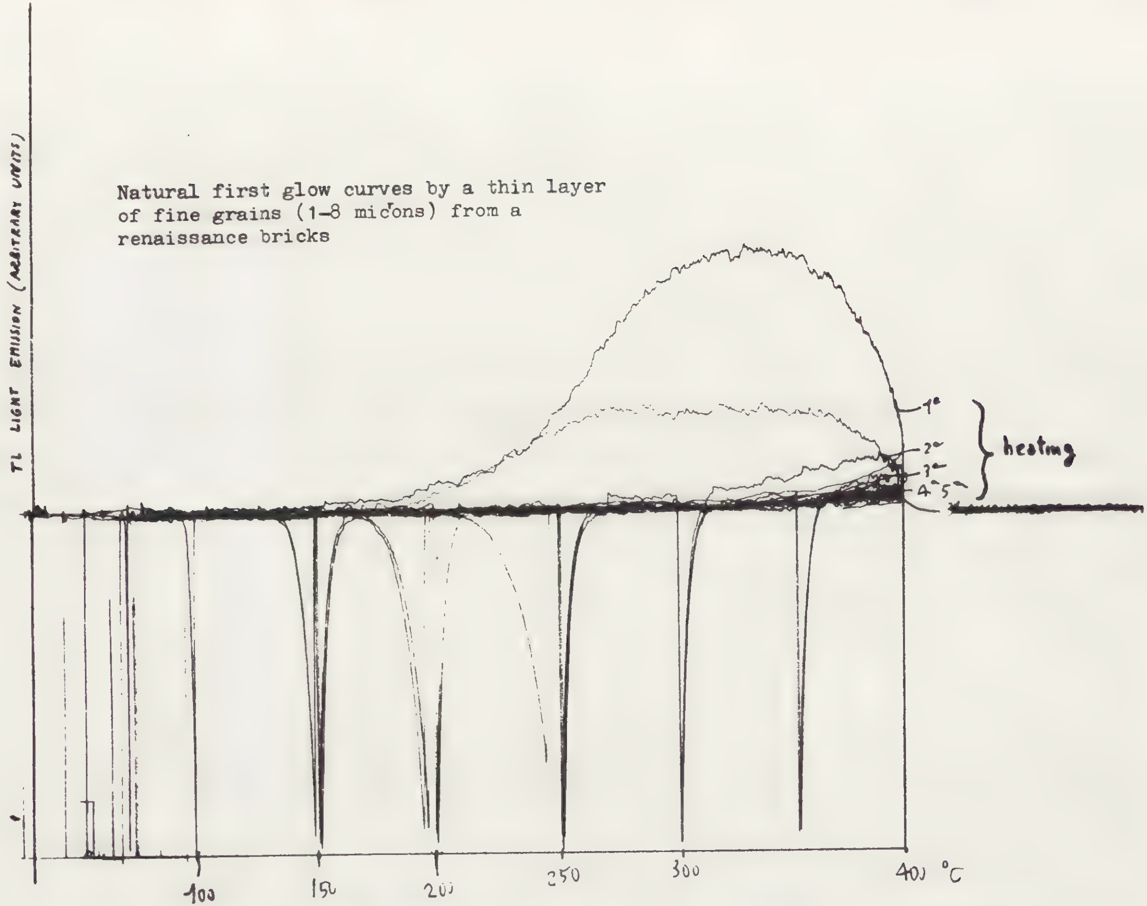
The terra-cotta and pottery investigation are described in the table.

At the present moment only the first step of the environmental radioactivity has been detected but all the samples are tested by TL measurement of archaelogical dose.

In the figure it is showen the TL glow curves of one sample

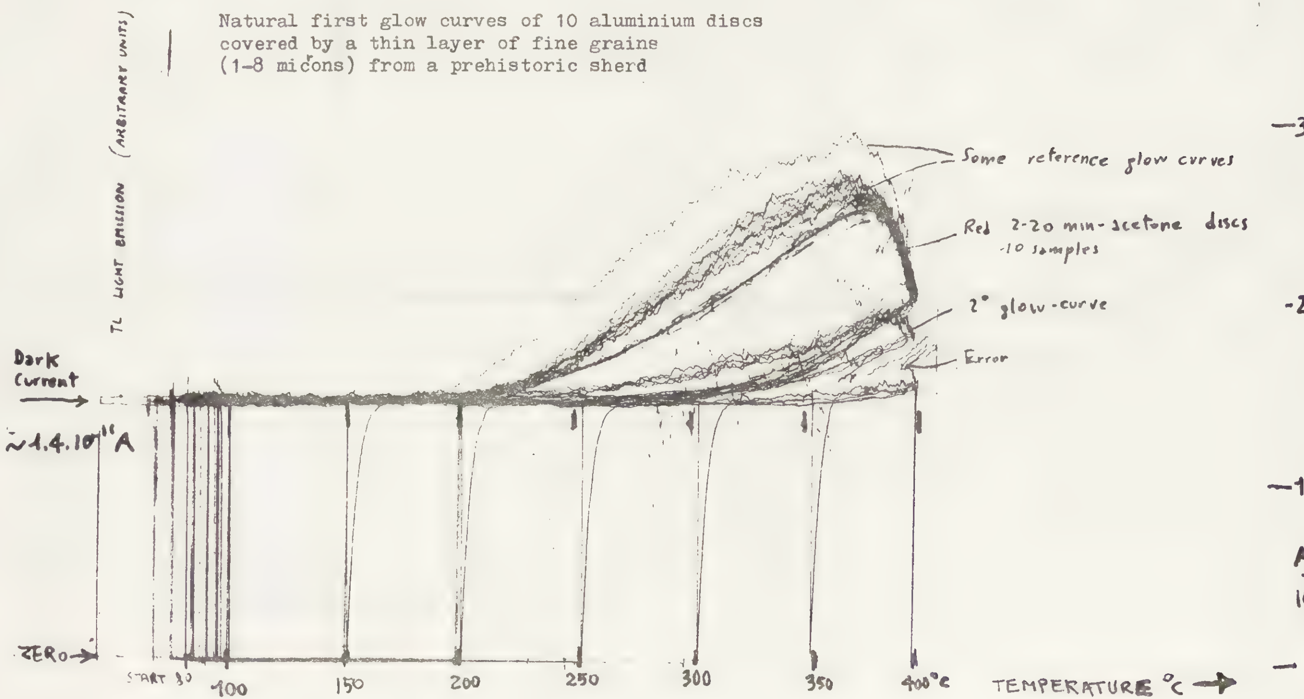
aknowledgement.

Many thanks to the Sovraintendenza ai Monumenti di Bologna, Architetto G.Vianello, and Sovraintendenza Archeologia di Bologna, Dr. E.Silvestri, for the kind delivery of the samples. Many thanks also to CNEN, Dr. Busuoli, for the use of the irradiation facilities.



Natural first glow curves by a thin layer
of fine grains (1–8 microns) from a
renaissance bricks

Natural first glow curves of 10 aluminium discs
covered by a thin layer of fine grains
(1-8 microns) from a prehistoric sherd



78/1/13/4

Kind of the sample	Country	Deepness mt.	Estimated Archaeological age
Bottom of vase	Vigorso (Bologna)	0.40-0.60	Iron? Bronz?
Piece of vase wall, black terra-cotta	Vigorso (Bologna)	0.40-0.60	" "
Piece of terra-cotta	Vigorso (Bologna)	0.60-0.80	" "
Piece of terra-cotta's impasto	Vigorso (Bologna)	0.80-1.20	Bronz?
Piece of wall with graffiti	Castenaso (Bologna) necropolis	0.80	Villanoviano II (VIII secolo a.C.)
Piece of brown terra-cotta	Castenaso (Bologna) necropolis	1.20	Villanoviano I
Piece of vase handle	Castenso (Bologna)	1.20	Bronz?
Brick	Abbazia Monteveglio (Bologna) south wall		
Brick	Abbazia Monteveglio (Bologna) absidiola Epistulae		
Brick	S.Michele di Nonantola (Modena)		
Brick	Vignola, tower (Modena)		

AMELIORATION DES TECHNIQUES RADIOGRAPHIQUES.
LE SCANNING.

Dominique Hollanders-Favart et Roger van Schoute

Les techniques radiographiques traditionnelles présentent deux inconvénients : 1° elles représentent un objet à trois dimensions sur une pellicule qui n'en comporte que deux ; 2° elles n'enregistrent qu'un nombre limité de niveaux de densité.
Le "Scanner" (de to scan = scruter) est un appareil de radiographie en usage dans le domaine médical depuis plusieurs années (1). Le mode opératoire se caractérise par le fait que l'on procède sur des coupes ou tranches de l'objet à examiner. Une source RX d'une part et un ou plusieurs détecteurs d'autre part sont soumis à une série de déplacements et de rotations par rapport à la coupe sélectionnée et enregistrent pour chaque point scruté le pouvoir d'absorption de celui-ci. Les différents groupes de valeurs mesurées sont transmis à un ordinateur qui, après calcul, reconstitue l'image de la coupe sur un écran. Cette image peut apparaître en noir et blanc ou en couleurs simulées, être photographiée ou encore être traduite en chiffres ; les données sont enregistrées. L'appareil présente donc une supériorité appréciable dans le domaine de l'information quantitative et qualitative.
Nos premiers essais ont été effectués sur un objet à trois dimensions (2). Il apparaît clairement que l'appareil peut fournir des informations nouvelles et surtout extrêmement précises à propos tant de la technologie de l'objet que de son état de conservation. En effet, il est permis de localiser de manière rigoureuse et de déterminer les différents éléments qui constituent l'objet ; des éléments pris isolément peuvent être identifiés ; la mise en oeuvre, l'agencement des éléments peuvent être observés ; enfin les répercussions des aspects technologiques sur l'état de conservation peuvent également être mises en évidence.
Malgré le coût élevé de fonctionnement, l'utilisation du "Scanner" peut être d'un appoint occasionnel pour résoudre des problèmes qui exigent une rigueur parfaite dans la prise du document et dans l'expression chiffrée des résultats.

(1) Il nous a été permis d'expérimenter le Scanner CT 1010 (EMI Medical) du service du Professeur G. Cornelis de l'Université catholique de Louvain ainsi que le Delta Scan (Ohio Nuclear-Siemens) du service du Professeur Baert de la Katholiek Universiteit Leuven, nous leur en sommes particulièrement reconnaissants. Nos remerciements vont également à Monsieur Van Dresse de l'Université catholique de Louvain ainsi qu'au Professeur Gybels et à Monsieur Seutens de la Katholiek Universiteit Leuven qui ont commenté pour nous le fonctionnement des appareils.

(2) Exemple de conditions : 120 kV, 30 mA, ± 2 minutes pour l'enregistrement complet d'une coupe de 34,5 cm de diamètre et 13 mm d'épaisseur.

STRUCTURAL RESTORATION OF PAINTINGS ON CANVAS

Coordinator : W. Percival-Prescott (U.K.)
Assistant coordinator: P. Boissonnas (Switzerland)
Members : G. Berger (U.S.A.)
M. Bjarnhof (Denmark)
B. Hallström (Sweden)
G. Hedley (U.K.)
F. Makes (Sweden)
G.E. Mâle (France)
V.R. Mehra (Netherlands)
S.Rees-Jones (U.K.)
F. Rigamonti (Italy)
E. Stöbe (Austria)
G. Urbani (Italy)

Programme 1975-1978

1. Alternative solutions to lining (Percival-Prescott, Lewis).
2. Stresses and strains in stretched canvas (Hedley).
3. Microstructural deterioration of paintings on canvas (Hallström).
4. Removal of lining adhesives and canvases (Boissonnas).
5. A suction hot table lining method (Bjarnhof).
6. Consolidation with Beva (Berger).
7. Traditional panel-press lining technique (Stöbe).
8. Comparative study of French lining techniques (Mâle).
9. Cold table relaxation techniques for paintings, textiles and paper (Mehra).
10. A new aluminium stretcher for oversize paintings (Rigamonti).
11. A new lining canvas.
Prediction of stress relaxation and incipient instability in lining canvases (Urbani, in collaboration with Parrini and Ronca).
12. Use of enzymes in the treatment of proteinaceous adhesives and surface coatings (Makes).

CONSOLIDATION OF DELAMINATING PAINTINGS

Gustav A. Berger

Abstract - A frequent cause of deterioration in paintings is the loss of adhesion or cohesion in the different parts of the paint films and their supports. The paint media, such as casein or drying oil, which are strong adhesives themselves, fail under the tensions generated by dimensional changes in the paint film and the support. Components of the painting are forcibly separated, cracks form in the horizontal direction, and later cleavages in the vertical direction.

The treatment of delaminations requires three operations: 1) Penetration of the consolidating adhesive between the delaminating layers, 2) Release of tensions within them, 3) Reattachment of the paint to its previous support.

Low viscosity and good wetting properties make Beva well suited for the treatment of delaminations, both of the adhesive and cohesive type. Beva's chemical stability, its strength and elasticity assure effective, long lasting bonds. Since Beva is easily reversible and can be reactivated at low temperature, it will not impede or weaken future consolidation measures. Its flow and elasticity prevent damage caused to the painting by other strong adhesives.

Consolidation of two delaminating paintings, one of them severely damaged by fire, is described in detail.

Introduction

Dimensional changes occur constantly in the different materials of painted objects creating stresses within each paint layer or between the paint layer and its substrate. The following causes result in dimensional changes which in turn lead to prolonged (lasting) stress in paintings:

1. Shrinkage of the paint layer,
2. Expansion of the canvas support due to the pull of the stretcher,
3. Sagging of the canvas under the weight of the painting,
4. Shrinkage or expansion of the canvas or wooden support due to high or low humidity,
5. Exposure to excessively high temperature or light.

Whenever the stress created by one or more of the above causes can no longer be absorbed by the plastic deformation of the paint layer a break occurs. When the stress exceeds the cohesive or adhesive strength of the materials holding the painting together the different

layers separate. Separation of the materials in a direction vertical to the plane of the painting is called cracking or tearing, while separations in the plane of the painting are termed blisters or delaminations.

In addition to the above listed causes, cracks and delaminations can also result from accidental impact or other short term movements of the support due to air flow, vibration or changes in humidity. Indeed, the form of the cracks on most paintings follows the pattern of short term stress. This fact has led some observers to conclude that short term impacts and humidity movements are the primary causes of cracks. That their conclusion is wrong can be proven as follows: 1) In most paintings only some paints crack while others don't, and each of those which cracked shows a different pattern, 2) If the movements of the substrate were in fact the primary cause of cracks, then cracks should form on every old painting whenever the substrate is moved; Yet some old masters' works show no cracks after 400-500 years, 3) Paintings on glass, stone and metal should not crack at all since their substrates practically do not move; This , however, is not the case.

In our own experience hundreds of cracked paintings were examined and photographed to form the nucleus of a collection for further research on cracks. While doing so we found that short term stress either breaks the painting immediately or it does not break it at all. When a break occurs the crack does not show immediately because to form the typical shape of a paint crack the paint film has to shrink and open the break. Otherwise it would be quite easy to have paintings crack at will - an age old dream of all fakers.

The dimensional changes which are innate to the aging process of the painting do not cease when cracking and delamination occur. They continue to deform and to tear the painting apart when proper steps are not taken against them. It is clear that a damage, such as cupping, can only take place if the paint film is susceptible to plastic deformation as a result of the forces acting on it. If held by a sufficiently strong adhesive on a solid support the paint film just cannot cup, as is evidenced by many 16th and 17th century paintings on wooden panels which have never cupped. It can also be seen on paintings of a similar age which were carefully lined centuries ago and as a result are in perfect condition today. However, old consolidation measures had to be repeated frequently. Only the use of more effective and stable materials will stop the damaging cycle of frequently repeated conservation measures.

Consolidation with Beva 371

Paintings are usually brought to the conservator only after delaminations and distortions have occurred. These can be remedied, at least temporarily, by reversing the effects of age: cross-linked and embrittled paint must be softened and made plastic again before it can be bent back and fitted into its previous position. It then must be readhered with an adhesive capable of attaching itself firmly to the

paint film to be consolidated. This step cannot be done without impregnating both the paint film and support with the consolidating adhesive at least locally. Since removal of any adhesive from a thin, fragile paint film is almost impossible, consolidation measures must be considered as practically irreversible. Therefore, special care must be taken neither to dislodge the loose paint, nor to impede subsequent or future conservation steps.

It is best to have a complete plan of action mapped out before the first step is taken. The steps of the most common course of consolidation are listed below; all of them must be taken into account if the optimal procedure is to be worked out. This is a guideline and should not necessarily be slavishly followed:

I. Examination and testing,
II. Facing, to prevent loose paint from falling off or moving during subsequent operations,
III. Infusion of the adhesive beneath delaminated films, since this is easier to achieve when the paint is loose,
IV. Softening of the paint film with pressure, heat and occasionally solvents in order to return the deformed paint to its original position (plastification, vapor-treatment),
V. Reattachment of the loose paint. This is usually achieved concurrently with either III or IV and consolidated by VI,
VI. Prolonged application of the above measures to permit the bending back of the paint film by slippage of the primary and secondary linkages (plastification, re-deformation),
VII. Removal of the facing. This step might have to be taken at any time during the process, in order to prevent the facing material from sticking to or being pressed into the softened paint film. Frequently, a new facing might be necessary after the infusion of the adhesive and after the surface of the paint film is protected by isolating varnishes. Varnishes often can not be applied at the beginning of the process because the paint film is too loose, and because varnish penetration would reduce the effectiveness of the consolidating adhesive.

A well consolidated paint film should be free of tensions after it has been bent back and reattached to its substrate. Its adhesive should be strong and elastic enough to resist future tensions and should not cause any such tensions itself (as has animal glue done in the past). The adhesive should be softer than the paint film in order to cushion tensions created by the substrate.

Below are practical instructions for a consolidation with Beva 371. Attempt has been made to mention all the alternatives in the sequence in which they normally occur. However, the author himself has published a number of consolidation procedures which did not follow this course. The competent conservator should be alert to the conditions which may force him to change his methods.

I. Testing Prior to Consolidation

Before attempting consolidation the following tests should be performed:

1. Discoloration test. A small, inconspicuos area of the paint film may be stained with hexane, heptane or naphtha. Should permanent discoloration be suspected, consolidation with glue, Klucel J. or soluble nylon may be considered. Soluble nylon is usually best when a painting is powdery. In difficult cases, as for instance gouache paintings, a further test with Beva is suggested: a small drop of Beva is applied to the paint surface and allowed to dry for 24 hours. Temporary discoloration often disappears due to the opacity of dry Beva. In most cases it is also possible to remove the excess Beva from the surface with the help of fast-drying solvents, such as Freon, acetone, hexane and others, before the solvents can weaken the already dry Beva film beneath.

2. Testing the resistance of the paint film to heat and solvents. Resinous paint might be softened by heat or pressure. At such point facing material may be pressed into it to an extent that it could no longer be removed without paint loss. Isolation of the paint film from the facing material by layers of varnish might help in such cases. However, layers of varnish might consequently impede the penetration of the consolidating adhesive, and should therefore be used only when absolutely necessary. The test is performed in the following manner: A cotton swab or piece of blotting paper containing the solvent is covered with a release material, such as Mylar, and pressed with a heated spatula (70°C) against an area of the paint film to be tested. Paint must not transfer to the cotton, nor should any fibers adhere to the film after 1-2 minutes. If there are any doubts, every individual paint film should be tested in this manner, beginning with the ones containing white and proceeding slowly to the darker films, particularly the reds. In sensitive cases, a conventional cleaning test with a cotton swab may preceed this test.

3. Testing the canvas for shrinkage due to heat and moisture. A piece of the tacking margin should be wetted, heated and then inspected for at least one hour thereafter. Shrinkage, especially on varnish drenched canvases, often is a very slow process. Even if no water is intended to be used in the treatment, this test is important because shrinkage might occur during heat application (1).

After these tests have been made, the facing may be selected.

II. Facing with Beva 371

By 'facing' a conservator understands the temporary support applied to the face of the painting. It is done in order to keep the loose paint film in its proper position relative to other parts of the paint film while it is treated and readhered often through the reverse, i.e.

consolidated. For this purpose thin, porous tissues are used which can easily be removed from the paint film. Often a painting is in such a precarious condition that a facing must be applied on location, before the painting can be moved to the conservation laboratory. Some paintings are so fragile that they cannot be examined before at least a partial facing is applied (See later in this report). In such cases Beva commends itself as the choice adhesive for temporary facings as it can be applied without pressure, causes no expansions or contractions either in the facing paper, in the paint, or its support, and because it firmly adheres to every known paint film when dry. Due to its low solution viscosity Beva is removable without difficulty even from loose, fragile paint layers. This is why applying a Beva facing is a simple matter and has been done by laymen thousands of miles away from our studio who followed written instructions. However, the conservator should be warned of several complications which might cause him additional work:

1) When the painting is torn, facing with Beva solution might make joining of the tears with a more resistant, stronger adhesive, such as epoxy, more difficult. Heat-seal facing or other facing glues which are more compatible with epoxy should then be chosen for the facing (1),

2) When the painting is so soft, or has to be softened to such a degree, that any facing and pressure could deform the paint film, the facing must be carefully removed, and the painting treated by low-pressure methods only, without using a membrane (See treatment of the fire-damaged painting, pp. 15-16),

3) Despite careful application, the facing paper does not lie flat but forms folds instead. This may be caused by one of two reasons: a) The paint film is badly distorted. If so, the facing paper should be applied in small pieces; b) The painting has heavy impasto. In this case, tissues made of thermoplastic fibers may be vacuum-heat-sealed to the painting after being adhered to it with a thin coat of Beva. Other methods were described elsewhere (2).

In routine cases of conventional easel paintings we use a 5% solution of Beva 371 in naphtha, slightly preheated in a water-bath. A complete description of the procedure appears later in this paper (See conservation of G. Washington's portrait, pp. 9-14),

4) For badly delaminated paint films, a Beva spray on an open-weave facing tissue is suggested.

III. Infusion of Beva

The infusion of adhesives into the paint layers, or impregnation of the painting, is usually performed after facing. However, there are cases where the paint film is so thin and brittle, and/or needs so much softening that even the finest facing might either damage it or prevent it from returning to its previous condition. Such a case is

described later in this report, where the facing was removed prior to impregnation with adhesives.

It should be noted here that a painting which is to be infused with Beva does not necessarily have to have a Beva facing, and that a Beva facing does not preclude the use of any other adhesive. Beva heat-seal facings have the special advantage of leaving optional the use of any other adhesive. The combination of a Beva facing and consolidation with Soluble Nylon or acrylic resin solutions or emulsions, animal glue or wax is convenient. The easy reversibility of Beva in low-aromatic petroleum solvents which are harmless to the painting, and have little or no effect on the other adhesives listed, makes such a combination possible. For example, the combination of a Beva facing and subsequent consolidation with wax is particularly convenient because Beva does not melt at the application temperature of wax, and therefore holds the paint film firmly in place while the wax is applied. Not only is Beva completely compatible with all the waxes used for consolidation, it also has the additional advantage of strengthening them. In most cases, however, it is preferable to use a stronger and more reliable adhesive for consolidation than wax. The conservator using acrylic emulsions or animal glue should remember that reactivation of the glue in the event of future failure will require the use of stronger solvents and higher temperature than Beva.

If Beva is chosen as the impregnating adhesive the canvas should be sufficiently straight to accept vacuum treatment on the hot table. Otherwise, it has to be straightened or stretched first. The infusion procedure follows:

The painting is faced with highly diluted Beva (5% - 8%) and allowed to dry overnight.

The Beva for consolidation is thinned to about 15% with a slow-drying solvent such as a mixture of xylene and odorless (1:2), and preheated in a double boiler.

The vacuum hot table is covered with a sheet of heavy Mylar (3 mil) and silicone-coated, thick and open-weave fiberglass.

The painting is put on the hot table, face down, and preheated to a temperature of about 100-120°F (40-50°C).

The reverse of the painting is coated with the warm Beva solution. Coating is repeated until the canvas is saturated with the adhesive and no longer able to absorb any more.

The painting is inverted. The faced paint film is also heavily coated with the warm, thin Beva solution (5-10%).

The painting is covered with a membrane of silicone-coated fine Mylar (0.5 mil). If another type of membrane is used, the painting must be covered with silicone coated paper first.

If extra heavy impregnation is desired, the painting is again coated with Beva solution from the reverse and put directly on a piece of silicone-coated Kraft paper which prevents the escape of surplus adhesive through the porous bottom layer.

Caution: At no time should it be attempted to forcibly peel the painting off its underlying release sheet. If any difficulty is encountered, the whole aggregate of painting and release should be inverted, and the release sheet peeled off the reverse of the painting, By doing so, the paint surface will not bend but lies flat instead.

There are three possibilities for further treatment:

a. Facing and membrane can be removed simultaneously,

b. Facing and membrane are removed separately,

c. The membrane cannot be removed.

a. Facing and membrane can be removed simultaneously. If the paint film is not too loose, the facing can be removed while still wet, as soon as the impregnation is completed:
The painting is put on the vacuum hot table for about 5-10 minutes to assure penetration of the adhesive;
The facing is coated with naphtha or a mixture of xylene and odorless and covered with the membrane for about 2-3 minutes;
One corner of the membrane is lifted together with the facing paper to see whether or not it is readily removable. If the paint film remains adhered to its support, removal of the facing together with the membrane may continue, provided that no part of the paint film pulls off the support at any point in the process. This type of consolidation is recommended in cases where the paint film lifts and is already loose at the cracks but each paint island is still held by the support.

b. Facing and membrane are removed separately. If particles of the paint film separate from the support and stick to the facing paper either on lifting the corner of the facing with the membrane or at any later time, the facing with the loose particles is immediately put back on the painting. The clean parts of the facing which have been removed are trimmed off.

While holding the facing down to remain attached to the surface of the painting, the membrane alone is carefully removed.

The painting is allowed to dry for at least one week.

An area of about 5x5" (12x12cm) is brushed with naphtha and covered with Mylar. Two-three minutes later, when the Beva softens, the wet piece of facing paper is removed and the area quickly dried. Removal of the facing proceeds, piece by piece as above, using small quantities of naphtha so as not to soften the bottom layers, until the whole painting is clean and dry.

c. The membrane cannot be removed. Sometimes the paint film is so loose that removal of the membrane is impossible before the adhesive has reached its full strength. In this case, the following is done:

Heat treatment continues until the painting is almost dry while still under vacuum.

The membrane is trimmed around the edges of the painting. The painting is lifted off the table and inverted, usually together with the silicone impregnated bottom sheet. The bottom sheet is peeled off the reverse, and the painting allowed to dry for at least one week.

The facing is removed a small area at a time, using small quantities of naphtha.

In cases where the paint film is very loose or cupped, heat-activation after drying and/or vapor treatment is also advisable before removing the facing.

Conservators using Beva adhesives have developed various consolidation procedures of their own. An important variation has been reported to the author by Dr. Erasmus Weddigen (3). Modern paintings with a delicate surface which cannot be touched at all are being consolidated by Dr. Weddigen with Beva 371 in the following way: by trial and error the solution, or suspension, of Beva is adjusted to be of sufficiently low viscosity to penetrate the canvas but too viscous to pass any further. This Beva solution is applied to the back of the painting in the delaminating areas only. Upon drying, the shrinking Beva pulls the loose paint back into its original position.

Similar results have been reported by Dr. Thomas Brachert (4) in the consolidation of a very delicate Swiss 15th century gouache paintings on panel, where Beva was applied from the face without causing any discoloration.

IV. Vapor Treatment of the Paint Layers (Plastification)

As the paint layers age they gradually loose their plastic properties as a result of cross linking and chain breakage (5). By introducing a solvent (lubricant) between the cross linked and entangled polymer chains, many secondary linkages can be dissolved. Some of the stronger solvents are obviously capable of breaking the cross links, otherwise they would not dissolve the old paint films. By applying such solvents

in minute quantities in vapor form, the paint film is effectively swelled and plasticized without any leaching at all. Margaret Watherston has published some practical applications of the process (6). Nathan Stolow advises that a material should be found which would replace the leached out parts of the paint film (5). Such a material could only be introduced in liquid form to act as a plasticizer for old paint films and make them flexible again. It would be the author's suggestion to test a large number of plasticizers which might restore some of the lost flexibility and volume to shrunken paint films. If the right plasticizer is found, it might even help reduce or prevent cracking which in some cases so badly disfigures old master paintings. Such a material might from the outset prevent the occurrence of cracks and delamination, which we have shown to be one of the prime causes of destruction of the paint film. So far, several successful experiments were made by the author by introducing small quantities of ethylene glycol or polyethylene glycol particularly into cracked glue and casein films (2). It would be up to the chemists in conservation to find better materials. Plastification is an essential part of consolidation because without it the loose paint cannot be bent back and brought into contact with its previous substrate again. All our consolidation methods at least use heat and moisture to soften the paint before it is reattached to its original support. A thorough investigation of the optimal methods for such procedures would be of utmost importance. *

Vapor Treatment for Beva Impregnated Paintings

Limitations of space make it impossible to treat this essential part of consolidation more thoroughly. However, as far as consolidation methods with Beva are concerned, partial and often sufficient plastification is already supplied by the solvents of Beva, applied as described above, at 50°C. When so indicated, a pretreatment in spray form is given, and the supporting canvas is usually lightly moistened before infusion of the adhesive. This is done in order to relax the support and to soften the old glue sizing, the priming, and the paint film (7). Often the painting is moistened and prestretched to flatten it sufficiently for the hot table. Thus, in the majority of cases no further vapor treatment is necessary.

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* Softening of the paint layer is an important part of every consolidation procedure: glue-paste with all its different ingredients, and heat, has a softening effect on the paint layer, as does the impregnation with wax. In recent descriptions of linings and preparations for lining, Westby P. Prescott exposes the paintings to moisture for very prolonged periods, thereby probably also affecting the shrinkage of the supporting canvas. This has a beneficiary effect on reducing cupping (7). Prof. Paolo Gori keeps the painting wet for at least 24 hours before lining (8) and uses a lining paste for the same purpose. Doerner also states that a softening of the paint film should preceed consolidation measures.

However, if there is a need for additional straightening of the paint film, the weave of the reverse of the canvas is filled with Beva gesso (1) and all the knots and slubs are removed before vacuum and vapor treatment in order to prevent their mark-through. The facing is then removed and a protective layer of several isolating varnishes substituted for it (6) in order to protect the brushwork and impasto. So far, the infusion of Beva has always been sufficient to hold the paint layer firmly in position during vapor treatment.

Time is frequently an important element in the plastic reformation of paint films, since slippages of secondary linkages in high-molecular polymers take considerable time because of the friction between the long molecules. Weights are often used to keep the paint film in place after it has been bent back.

A veneer press, heated or otherwise, with proper cushioning (even an air cushion) often gives very satisfactory results in cases where everything else has failed.

A method, commonly used by old liners, was bending the cupped paint film in the opposite direction thereby inducing rapid plastic deformation, or at least breakage, on the reasoning that half a cup is much shallower than a full cup. In this process, still used by some liners, the whole painting is sharply bent face out. An interesting variation of this method is described in our own treatment of a heavily cupped painting by Miro (9).

After completed consolidation, the back of the painting is given another thin coat of Beva, usually by spray, to compensate for any losses of adhesive which might have occurred during treatment.

Following are two conservation reports on consolidation with Beva 371. More examples were previously published.

<u>George Washington, by Charles Wilson Peale</u> (American, 1741-1827), oil <u>on glue-lined canvas, 26 x 20¼" (66 x 51cm)</u>, Private Collection (Shortened conservation report).

<u>Condition:</u> Extensive cleavage over most of the surface of the painting. The cleavages seem to indicate an almost complete adhesive failure between canvas and priming, an occurrence not infrequent in glue-lined paintings with strong interior tensions.

The paint film is heavily cupped and exceedingly brittle and dry(Fig.1).

The painting is covered with a heavy layer of discolored, opaque varnish which obscures the painting, particularly the blue background.

Treatment (June, 1976):

Temporary facing and removal from the stretcher, The painting was put on the working table while still on its stretcher, A piece of wet-strength tissue was put on top of the painting and a 5-8% solution of Beva 371 in Solv, B (Amsco Chemical Co.), preheated in a double boiler, was applied through it by brush. The brush was quickly dipped in the hot water of the double boiler, and a small amount of water was brushed and stippeled into the facing paper to soften and slightly expand it, Absorption of a large amount of water was prevented by the Beva coating of the facing paper. The small beads of water appearing on the surface were pushed from the center to thesides with a paper towel together with the few wrinkles which formed. All excess Beva was removed in the process. However, there is no real need to remove all the wrinkles because the facing paper shrinks and flattens as it dries.

The painting was removed from its stretcher the following day, after the facing paper was completely dry and adhered to the face of the painting. The tacking edges were inverted on a clean piece of silicone coated Kraft paper, and flattened with a heated spatula using a mixture of water and alcohol (1:1) as a softener.

Infusion of Beva. Though the paint film was secured by the facing paper and could no longer fall off, its bond to the original canvas was precarious because it was so cupped and brittle. Had the painting been put face down on a board and exposed to pressure, the shear stresses necessary to remove the hard glue paste and lining canvas from the back would have pulverised the brittle paint layer. The paint was therefore softened by slightly spraying the faced painting with various mixtures of solvents and water. Because of the minimal amount of Beva used in the temporary (first) facing, the solvents readily penetrated from the face as well as from the reverse. The painting was kept for several days in a cardboard box which is usually prepared in our studio for every painting, in order to protect it during handling and transportation. The box was wrapped in polyethylene film to keep the sprayed-on solvents from escaping, thus assuring an effective Pettenkofer vapor treatment. The painting was then further softened by an infusion of Beva, before attempting to remove the old glue-lining (The solvents in Beva have an additional beneficiary effect).

The hot table was covered with a sheet of Mylar (2.0 mil) and a piece of open-weave, teflon-coated fiberglass, which was additionally coated with silicone. The purpose of the fiberglass was to assure a uniform vacuum and continuos exhaust of fumes from under the painting, and to serve as a receptacle for any surplus adhesive that might be sucked through the painting during impregnation.

The vacuum table with the Mylar and fiberglass on it was then preheated. At the same time, a 12-15% solution of Beva was made by adding

two parts of the slow-drying solvents (Amsco Solv. B) to the commercially available 40% dispersion of Beva 371, and preheated in a double boiler. When all was ready, the painting was put on the silicone-coated fiberglass and thoroughly drenched with the warm, diluted Beva, by several applications through the facing paper. The painting was placed on the silicone-coated fiberglass in such a way that a sufficient margin (about 10cm all around) was left to provide ample space for any surplus glue used in the impregnation. This is necessary to prevent the surplus glue from being drawn into the exhaust system of the vacuum pump, thereby "gumming up the works".

The solvents of Beva have an additional softening effect on the paint film, especially at the elevated temperature at which it is applied. The raised temperature has a multiple effect: it softens the paint film, permits it to be bent back into its original position, and reduces the viscosity of the Beva solution to make deep penetration possible.

The heated painting was covered with a silicone-coated Mylar membrane (Du Pont, 0.5 mil). The air under the painting was partially evacuated creating a low-pressure area under the painting. Because of the vapor pressure, the membrane on top of the facing paper usually forms one or more bubbles, which prove that there is no pressure on the painting at this stage. After a short wait, usually a minute or two, the painting reaches the temperature of about 50°C, and Beva begins to penetrate deeply between the loose paint layers. At this point it is possible to start bending down the loose, cupped, paint locally, using one's fingers or an agate stone. The bubbles can be removed by rolling a soft rubber brayer over the surface of the painting. This action also presses the Beva deeper under the paint layer, and helps to distribute it more evenly. Finally, any surplus adhesive is pushed out onto the margins of the silicone-impregnated fiberglass. Since by now only a minimal amount of adhesive is left in the facing paper and on top of the painting, it dries quickly even under the membrane. Pressure forms on top of the painting by the action of the vacuum on the membrane, and the underpressure beneath the painting begins to increase. At this point it is good to wait until the pressure gauge becomes stationary.

The painting is then slightly lifted while two adjacent corners of the membrane are raised. This causes a sudden rise in pressure and a drop in temperature. We believe that the vacuum treatment creates underpressure within the voids and crevices of the painting which does not necessarily mean that the adhesive can flow into them because it is being pulled back by an equal or lower vacuum outside the cracks. The sudden rise in outside pressure upon lifting the membrane and the shrinkage of the vapors caused by the sudden drop in temperature, should draw the adhesive deeply into the voids of the painting.

The painting was dried under vacuum pressure of 200 mm at the gage

and a temperature of 50°C for several hours, thus allowing sufficient time for the reversed plastic deformation to set, and the delaminating paint film to firmly adhere with Beva. The painting was then removed from the hot table and allowed to dry and rest for one week.

After a week the painting was again put on the hot table under pressure, and this time heated to 65°C for about 5 minutes only. This activation of Beva increased its strength. The membrane was lifted, the face of the painting coated with Solv.B, and immediately covered with the membrane again. After 1-2 minutes, the facing paper could be removed in one piece, with no difficulty. The last visible traces of Beva were washed off with Solv.B, and the painting put under pressure using a new, clean, silicone-coated-Mylar membrane.

Cleaning and Relining. The painting was cleaned of its old varnish. All the old lutings and fillings were carefully checked, corrected where necessary with glue-gesso, and new ones added. This checking was important to make sure that no old unsatisfactory gesso or other accretions would be pressed into the paint surface during the removal of the old lining canvas and the subsequent relining. It would also save the relined painting unneccessary exposure to the action of cleaning solvents which might weaken the relining. It would minimize the effect of the solvents used to remove the second facing, since these could not penetrate the gesso fillings, or to a very limited extent only, the already closed cracks. For these reasons it was possible to safely use Beva also for the second facing, and take advantage of its superior adhesive strength.

The painting was given a heavy coat of Rembrandt varnish to protect its surface during subsequent treatments. It was then placed on a piece of silicone-coated Kraft paper and another piece of wet-strength facing paper, some 3cm larger than the painting all around, was adhered to its surface, following the procedure described before but extending the Beva coating over the edges of the painting to cover the margins as well.

After the painting has dried, the hot table was covered with a sheet of Mylar, and the painting laid on top of it, face up. A piece of Kraft paper has been heavily coated with Beva 371 on one side and kept in a humid environment overnight. It was cut to exceed the dimensions of the facing paper (about 10cm larger than the painting all around), and put on the faced painting with the Beva-coated side down. Upon heat-activation under vacuum pressure, the Kraft paper was adhered to the facing and its margins to the Mylar covering the hot table. After bonding the painting to the double facing, the Mylar was trimmed around the edges of the Kraft paper and inverted. The Mylar was attached to the protruding margins of the facing paper only. Since the back of the painting had not yet been coated with Beva, it did not adhere to the Mylar. The free Mylar was cut out along the inside lines of the edges of the Kraft paper. The Kraft paper margins were then moistened with water and adhered to a clean board of plywood

(15 mm thick), with the Mylar-covered side up. The Mylar covering the margins protected them during removal of the old lining canvas and glue. More importantly, the Mylar prevented the penetration of solvents to the underside of the painting during removal of the second facing.

The above described strong and secure double facing is primarily used in the rare cases when a transfer is unavoidable. It was decided to use it for this painting because of the precarious condition of the paint film. The fear that the consolidation measures through the face of the painting might not suffice to keep the painting attached to its original canvas was great. During removal of the glue-paste, which was a glassy film, the penetration of Beva proved no obstacle. However, Beva could only penetrate those areas where the paint layer was loose. There it provided a satisfactory bond. Where it could not penetrate, the adhesion between ground and original canvas remained insufficient and could not withstand the stress created during removal of the old lining canvas and hard glue. Blisters formed on the back of the painting, and it seemed that almost all over the painting the bond between canvas and ground no longer existed*. The painting was a serious candidate for a transfer. However, because of its historical value, and also because the areas where Beva penetrated were already well secured, it was decided against a transfer. Instead, the loose spots were locally consolidated by injecting Rhoplex 385 (Rohm & Haas), an acrylic emulsion, after completed removal of the old glue. An aqueous emulsion was selected because its water content would soften the canvas and facilitate its readhesion, while at the same time leave the already successfully consolidated areas with Beva unaffected. Besides, Rhoplex 385 dissolves only in pure toluene and therefore resists the solvents of Beva, an added safety factor in case the Beva lining should have to be removed some time in the future. Still not too sure about the adherence of the ground, it was decided to give the reverse of the painting a coat of very dilute Beva in toluene. The purpose was to reactivate the Rhoplex while holding the painting on the vacuum table in low temperature (50°C0 and under low pressure (200mm at the gage) for an additional four hours to assure a good bond.

A knife-coat of Beva gesso containing calcium carbonate ($CaCO_3$) was applied to the back of the painting to protect it from the effects of acid air pollution and to even out its surface which had suffered because of the difficulties in removing the glue. The painting was then relined on a double layer of fiberglass with a sheet of heavy Mylar (5 mil) between them to add rigidity.

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* We have since encountered a similar situation several times particularly on paintings which were mounted with aqueous glues to a solid support.

It was time to take off the Beva facing which held the painting during removal of the old lining. Care had to be taken not to soften the already finished Beva relining. The paper was lightly scored along the edges of the original canvas. The margins of the Kraft paper were coated with Klucel J in order to prevent penetration of the petroleum solvents which were also stopped by the adhered Mylar margin described on p. 13 (top). The facing was then drenched with naphtha and covered with a sheet of Mylar. After 8-10 minutes, one corner of the Kraft paper was cut through at the edge of the actual stretching margin, and tested for adhesion. When the adhesive became soft, the center of the Kraft paper facing was rolled off the underlying wet-strength tissue. Additional naphtha softened the adhesive holding the wet-strength tissue, and it too was peeled off.

The consolidated painting was stretched on a new, custom-made French-type stretcher, cleaned and restored, in the manner described in detail in another report by the author (1) (Fig. 2).

Discussion

This report points out the difficulties conservators encounter when called upon to consolidate badly delaminated paintings. The solution described above is rather complex, and a simpler procedure might have been devised had it been decided from the start to transfer the painting.

There were no promising alternatives: the painting showed the failure of aqueous hide glue as a consolidant too clearly. Its use could therefore be ruled out; It would have been difficult to impossible to achieve the preliminary consolidation with wax, or could it bond a strong facing for the safe removal of the old lining canvas and hardened glue paste from the reverse. Acrylic resins might have been used for facing and consolidation, but not for relining, and the complications would have been similar to those described.

After removal of the glue, impregnation of the painting with wax could have been easily accomplished, and a wax-lining carried out. However, it would leave the large part of the paint layer adhered with wax only, and removal of the canvas by heat (reversal of the lining) could result in extensive paint losses because the paint would be loosened simultaneously with the relining canvas.

In contrast, the use of Beva 371 assured firm, fast drying bonds which had been previously tested, and with which we were familiar. Beva could be infused in higher concentrations than comparable acrylic resin solutions due to the low viscosity of Beva solutions. In addition, the low viscosity of Beva solutions made it possible to remove the facings without any paint loss.

Treatment of a Badly Fire-Blistered Oil Painting

"Twin Sisters", three-quarter length portrait, by Vic Lallier, 1951, oil on canvas, 48 5/8" x 34 5/8" (123 x 86cm).

Condition: Extensive and closely spaced blisters, particularly in the area of both faces, some of them 3cm long. The greater part of the portrait, and particularly the blistered area is covered with heavy soo

Treatment: The application of the facing was complicated by the fact that the owner lived 3000 Km from our studio and some 300 Km from the nearest city, New Orleans. Written instructions on the application of a Beva facing, and subsequent packing for the trip to New York, were closely followed and as a result the painting arrived with no further damage.(Fig. 3).

The faced blistered areas were sprayed from the front and the back with softening solvents containing about 1% of polyethylene glycol. The painting was then put in a cardboard box and wrapped with a polyethylene sheet. After four weeks of treatment it became evident that the paint was still too brittle to be bent back at room temperature. It was therefore decided to soften the blisters by heat. To do this, the painting was removed from its stretcher and its stretching margins flattened with a heated spatula. It was then put on the vacuum hot table which was previously covered with a silicone-coated Mylar sheet (2,5 mil). The table was heated to about 45°C to enhance the action of the solvent mixture of xylene and odorless on the facing glue which was applied very freely. Wherever possible, the facing glue was washed off together with the soot, sometimes by increasing the efficacy of the solvents with small amounts of detergent and oxydized solvents. In the heavily damaged areas the soot could not be removed at this stage even with the softest brushes without causing paint loss. A special way to infuse the blisters with adhesive and soften them had to be found before any pressure at all could be applied. It was decided to utilize our method of vacuum treatment without a membrane.

For this purpose the hot table was again covered with Mylar and a sheet of very rough, open-weave, teflon-coated fiberglass slightly larger than the painting. A strip of Beva was painted on the portrait around the badly blistered area of the faces. The painting and the hot table were then covered with a membrane of silicone-coated Mylar (o.5 mil) which was cut out where it covered the faces, as soon as the Mylar adhered to the Beva strip. The air was exhausted with a vacuum pump of about $1.10^5 cm^3$ per minute capacity, from several points around the painting at the same time, going as near as possible to the damaged area. As a result the air was mainly drawn through the blistered area while the painting was held firmly attached to the hot table. The temperature was raised to 65°C and the blistered area generously doused with warmed mixtures of xylene and odorless, using a soft, disposable housepainters' brush. Heat and solvents softened the paint to such a degree that diluted Beva could be painted on the blistered area.

The increasing viscosity of Beva slowly reduced the flow of air through the cracked area into which it was drawn, causing most of the blistered paint to be pulled back into its previous position. For the largest blisters some help with a spatula was necessary (10).

After further infusion of Beva and additional removal of the soot, the opening in the membrane was closed with another piece of silicone-coated Mylar, the same as the rest of the membrane, and the reattechment of the blisters was completed with a heated spatula. In most cases this could be accomplished with a minimum of damage to the texture of the painting (Fig. 4).

Discussion

The successful result of treating this badly distorted paint film is due to the low viscosity of Beva which permitted the paint to return to its original position with minimum heat and pressure. It proves that with a well thought out method even the most distorted paint can be reformed with minimal loss of texture.

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Fig.1 and Fig.2 George Washington (detail) before and after treatment

Fig. 3 and Fig. 4
Fire damaged double portrait (detail)
before and after treatment

DIAGNOSTIC FACTORS AFFECTING THE STRUCTURAL RESTORATION OF PAINTINGS ON CANVAS

Björn Hallström

ABSTRACT

Some aspects on the importance of diagnostic procedures in the structural restoration of paintings on canvas are discussed. If the treatment of works of art is related to the nature of damage the idea of restoration and conservation may be interpreted as care and protection.

Qui bene cognoscit
bene medebitur

(From a handbook in medical diagnostics, Leipzig 1839)

In the structural restoration of paintings on canvas one of the most important prerequisites is in fact the diagnostic procedure. Treatment of paintings is often carried out on the basis of subjective consideration of what may seem right and suitable in a certain situation. Lack of time is usually considered an important motive for immediate operative activity, reducing the possibilities of bringing the diagnostic examination to a reasonable degree of scientific reliability. Evidence to establish that the actual treatment planned is the correct one may thus be spoiled.

Even if the qualities of colour basically depend on largely subjective perception there are certain properties of paint which may be described in objective terms: refractive index, hiding power, scattering power and structural features such as particle size and distribution and thickness of respective layers.

The structure of paint in works of art is often described using cross sections. It must be said, however, that fragments of paint being embedded are often subjected to radical alterations. A paint layer thickness may change due to the interaction of highly reactive chemical compounds used for the embedding. Leaching often takes place. The porosity of the paint as well as its various microbial

structures, which often provide useful information and evidence about the history of the object, tend to disappear. The cross sections must therefore be interpreted as artefacts.

The structure of paintings can be studied without or with very little manipulation in a scanning electron microscope (SEM) which gives valuable information not only about solid particles but the more or less viscous components of of the paint. The structures of paintings include microorganisms and non-materialized elements such as porosity, i.e. the absence of materia in the aggregate. Such elements are often neglected and destroyed when paintings are lined.

On the other hand the coating of the specimen with carbon and metal may give raise to artefacts. Alterations in the specimen may also occur due to the energy of the beam (charging, deformation, cracking). However, the effects of bad coating, charging etc. are already well known and published, and the risk of misinterpretation is thus reduced. Working at a low accelerating voltage examination can even be carried out without any coating at all. For a rapid structural analysis of fragments of paint the SEM has proved to be a useful tool which is nowadays about as expensive as a technically advanced automobile- and about as easy to operate.

The Lining Cycle by Westby Percival-Prescott, a paper given at the Lining Conference in Greenwich 1974, also translated and published in Swedish (Stockholm 1975), reveals a great deal about the historical background and the motives of lining. In a recent publication (Bulletin. Centraal Laboratorium voor onderzoek van voorwerpen van kunst en wetenschap. Nr.0 September/Oktober 1977 p.1 ff *Het doubleren van schilderijen- Een nieuwe benadering*) V.R. Mehra and J. Voskuil have referred to Percival-Prescott and stressed the importance of the Greenwich Conference and the advisability of a certain restraint and precaution in lining.

It is a pity that more attention is devoted to the problems of treatment than to the explanation of damage. Pathology of paintings and the standard methods of diagnostics in conservation have not been fully developped and are still not generally accepted. Structural analysis for the structural restoration of paintings is more often regarded as a topic of conversation rather than a method of conservation.

It is important, however, to introduce some possible diagnostic procedures or, at least, to formulate some aims. There will be a display made for the Zagreb Conference showing means of structural analysis as an introduction to clinical diagnostics for the restoration of paintings on

canvas. The matter has briefly been considered in some papers given at the Lining Conference in Greenwich 1974, *Remarks on Relining* by Frantisek Makes-Björn Hallström (Stockholm 1972) and *Microbial Environment* by Bo Göransson-Björn Hallström (Dokumenta. Stockholm 1974).

I have summarized some possible aspects of the diagnostic procedure.

1. The *history* and the *origin* of the object.

2. The *environment*. History, present situation, subsequent history.

3. Subjective *characterization* of symptoms in perceptive terms (comparable to a patient's version of his illness) such as: discolouration, surface damage, brittle support, flaking, etc.

4. *Localization* of supposed damage related to the structure of the painting: support, isolation, grounds and other paint layers, and coatings, and further additional components. It must be kept in mind that changes in perceptive qualities may only be symptoms of alterations taking place somewhere else, not necessarily where the symptoms appear.

5. *Status.* This is the most difficult and controversial judgement. The status of the object must be related to an estimation of what may be regarded as representative from a strict technical point of view, without subjective and aesthetic consideration. I have used the word *equilibrium* to describe a technically balanced status of an object and its components. Damage may thus be difined as a disturbed equilibrium. The factors which have caused the disturbance may be endogenous or exogenous. The effects are in most cases irreversible and conservation can hardly bring the item back to its original status.

6. *Diagnosis*, also its resulting judgement. The decision must be impartial and based on facts. The situation is comparable to that in medicine and in forensic science.

7. *Supposed effects* and *consequenses* of treatment suggested related to the object and its environment.

The diagnostic procedure thus outlined does not cover the aesthetic factors. It is confined to physical *damage*, but conservation and restoration have very much to do with the visual, aesthetic values of works of art. I do not ignore such qualities, but I would like to stress the importance of works of art as *documents* and conservation and restoration as *care and protection*, a motto formulated by Hanna Jedrzejewska for the International Committee of Ethics in Conservation (ICEC).

LE RENTOILAGE FRANCAIS A LA COLLE: ANALYSE DES CONTRAINTES MISES EN JEU LORS DES OPERATIONS DE RENTOILAGE. COMPORTEMENT DE CE RENTOILAGE SOUS L'EFFET DE VARIATIONS CLIMATIQUES SIMULEES.

S. Bergeon, Y. Lepavec, M. Sotton et M. Chevalier

RESUME

Des rentoilages expérimentaux à la colle ont été réalisés de manière à suivre les déformations et les tensions développées aux divers stades de l'opération. Des essais ont également été conduits sur des éprouvettes, prélevées dans ces rentoilages fictifs, de manière à étudier leur comportement sous l'effet de variations climatiques cycliques, simulées en enceinte d'environnement. Les variations dimensionnelles ont été enregistrées en continu, sur des éprouvettes libres de s'allonger ou de se rétracter, ainsi que les relaxations et recouvrances sur des éprouvettes tendues. Ces essais ont permis de définir le rôle de la toile de doublage, l'influence du tableau fictif (contexture - nervosité), ainsi que celle de la colle (taux de colle - nature de la colle).

I - INTRODUCTION

Le rentoilage de tradition française à la colle se caractérise par l'adhésif (colle de pâte à base d'amidon) (1) et par sa méthode mettant en jeu une toile neuve de doublage en lin assez épaisse, décatie deux fois (cf. tableau 2) et le remplacement du cartonnage initial par un papier le plus souvent du type calque c'est-à-dire s'allongeant beaucoup à l'humidité. Une première étude menée à partir de 1975 par l'INSTITUT TEXTILE DE FRANCE en collaboration avec le Service de Restauration des Peintures des MUSEES NATIONAUX a permis de connaître les forces en jeu lors des opérations de rentoilage, d'expliquer le rôle du double décatissage et de connaître dans le cas de rentoilages fictifs les accumulations de tensions ou relaxations en fonction de variations climatiques : ces derniers essais étant originaux par rapport aux publications antérieures connues à ce jour. Une deuxième étude en 1977 avec ce même Institut a consisté en une comparaison des différents rentoilages entre eux parmi ceux les plus utilisés actuellement dans le monde et si certains éléments de cette dernière étude sont intégrés dans le texte ci-dessous (Alcamer et cire-résine sur lin), l'ensemble des résultats fera l'objet d'un article ultérieur.

Historiquement, le rentoilage est documenté dans les collections royales françaises depuis la fin du XVIIème siècle : en 1688 la Veuve LANGE a rentoilé la Vénus du Pardo de TITIEN (2) ; la

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tradition française est la méthode à la colle avec quelques modifications des ingrédients secondaires à la fin du XVIIIème siècle pour essayer de lutter contre les effets de l'humidité. Si à l'étranger vers le milieu du XIXème siècle le rentoilage à la cire est courant au Nord de l'Europe, la tradition de la colle se maintient dans le Sud. Dans les années 1930 des études sont menées aux USA pour déterminer les avantages respectifs des rentoilages à la cire et à la colle et essayer de leur comparer la nouveauté de l'époque le rentoilage aux matériaux vinyliques (3). De longues années de polémiques s'ensuivirent selon que l'on attaquait l'introduction d'humidité nécessaire de la méthode à la colle ou l'éventuel changement de couleur dans le cas de la cire-résine. Une date importante fut 1969 où G. URBANI au Congrès de l'ICOM à AMSTERDAM a posé la question de savoir si le rentoilage devait bloquer les variations de l'oeuvre en fonction du climat ou au contraire être une structure souple de soutien sans aucune contrainte ? En 1972, à MADRID le congrès de l'ICOM a présenté les premiers fruits d'une collaboration entre l'INSTITUT DU TEXTILE de MILAN et l'ISTITUTO CENTRALE DEL RESTAURO de ROME, à propos de fluage et la diversification des méthodes de rentoilage : le procédé Mehra au plextol natrosol sur polypropylène qui évite les écueils de la chaleur et de la pression ; le procédé Berger à la Beva 371 (4) qui évite certains des écueils de la cire-résine avec de nombreux tests scientifiques à l'appui. En 1972, en Suède (5) on préconise d'éviter au maximum les rentoilages et de faire une hydrolyse partielle de l'encollage original d'un tableau trop craquelé. En 1973, dans l'importante publication sous la direction de G. URBANI, Problèmi di Conservazione, le chanvre, le polypropylène et la toile de verre sont étudiés et l'accent est mis sur l'importance de la tension des toiles pour leur comportement futur. Enfin, au Congrès sur le rentoilage à GREENWICH en 1974 les études scientifiques et techniques ont été poursuivies sur les matériaux modernes aux USA (BERGER) et sur le fluage de textiles enduits en Italie tandis qu'une intéressante méthode à la cire-résine dans une enveloppe souple était mise au point à LONDRES.

L'étude ci-dessous a pour but d'une part, de connaître les forces en jeu lors des différentes opérations du rentoilage à la colle de type français et, d'autre part, de commencer à aborder l'aspect stabilité dimensionnelle de celui-ci en fonction des variations climatiques en le comparant avec des rentoilages fictifs à l'Alcamer (7) ou à la cire-résine (8). Mais restera à étudier le problème très important de la reprise des déformations et de la résorption d'un réseau de craquelures qui sont les qualités d'un rentoilage à la colle.

II - ETUDE DU PROCEDE DE RENTOILAGE A LA COLLE

Cette étude a été conduite sur un tableau fictif constitué d'une toile en lin recouverte d'une couche de préparation, rentoilé sur une toile de doublage en lin. Les caractéristiques du tableau fictif et la contexture de la toile de doublage apparaissent respec-

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tivement dans le tableau 2 (essais 1975) et le tableau 1. L'opération de rentoilage peut être décomposée comme suit :

1) montage de la toile de doublage sur châssis et décatissage - 2) préparation de la toile "décatie": léger ponçage avec papier abrasif, enduction de colle - 3) pose du tableau fictif muni de son cartonnage - 4) séchage - 5) repassage et décartonnage.

Le stade du décatissage a fait l'objet d'une analyse détaillée, les autres opérations 2 à 5 ont été étudiées plus sommairement au cours d'une opération de rentoilage fictive effectuée sur dynamomètre à partir d'une éprouvette de petite dimension.

II.1 - Décatissage à l'échelle réelle

Une opération de décatissage a été effectuée à l'échelle réelle sur bâti de 85-110 cm.

Afin de saisir le plus de renseignements possibles sur les déformations communiquées à la toile à chaque stade de cette manipulation, deux types de mesures ont été effectués :

a) - l'allongement en chaîne et en trame à chaque phase de mise en tension de la toile. Ce type de mesure a demandé une préparation particulière, de la toile de doublage, préalablement à sa pose sur bâti. Des repères ont été tracés sur la toile de manière à constituer un véritable réseau de lignes s'entrecroisant à angle droit tous les 10 cm et parallèles respectivement au sens chaîne et au sens trame. Ce véritable carroyage de la surface de la toile de doublage a permis de mesurer avec précision les déformations communiquées à chaque point de la surface

b) - la flèche, au niveau du centre de la toile tendue. Cette mesure a été effectuée sous charges (10 g - 110 g - 200 g - 1000 g) après chaque phase de la manipulation. Les positions des charges ont été repérées au 1/10 de mm à l'aide d'un cathétomètre (les résultats des mesures apparaissent sur la figure 1).

Les résultats de cette analyse d'un rentoilage réel permettent de faire les observations suivantes :

1) Première mise en tension

L'allongement communiqué a été chiffré à 7,61 % en chaîne et 0,22 % en trame.

2) Mouillage et brossage

Les mesures de flèches indiquent un faible, mais caractéristique relâchement de la tension.

3) Séchage et massage

Détension complète de la toile.

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4) Nouvelle mise en tension

Les allongements, par rapport à l'état initial, sont alors de : 12,27 % en chaîne et 0,56 % en trame.

5) Nouveaux mouillage et brossage

A l'issue de cette opération, cette fois, le tissu se tend (voir résultats de flèche fig.1), contrairement à ce qui avait été enregistré lors du premier mouillage.

6) Séchage - massage

Nouvelle relaxation des contraintes.

7) Mise en tension définitive

Au terme de cette opération l'allongement global donné est donc : 14,8 % en chaîne et 0,76 % en trame.

L'opération de décatissage a pour effet de modifier profondément la contexture de la toile de doublage (tableau 1) et notamment de réduire considérablement, du fait des mises en tension successives, l'embuvage des fils chaîne.

TABLEAU 1

Contexture de la toile de doublage, avant et après décatissage

Caractéristiques	Toile initiale	Toile décatie
Poids au m2	333 g/m2	327 g/m2
Nombre de fils en chaîne	17,3 fils/cm	17,3 fils/cm
Nombre de fils en trame	12,7 fils/cm	10,7 fils/cm
Embuvage chaîne	18 %	7,4 %
Embuvage trame	2 %	2,2 %
Titre des fils chaîne	105 tex	109 tex
Titre des fils trame	93 tex	109 tex

II.2 - Simulation d'une opération de rentoilage complète

Un cadre d'extension a été réalisé pour cet essai : il est composé essentiellement de deux montants cylindriques rigides et lisses pouvant être écartés parallèlement grâce à deux tiges filetées. L'éprouvette (toile de doublage) a été découpée en forme de croix à bras symétriques, de manière à être, d'une part, adaptée sur les mâchoires d'un dynamomètre et d'autre part sur les montants du cadre. La partie disponible au centre de l'éprouvette était réduite à 15 cm x 20 cm.

L'opération de décatissage réel ayant indiqué que la toile s'allongeait très peu sens trame c'est donc le sens trame qui a été choisi pour être tendu avec le cadre : pour ce faire, des repères ont

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été préalablement tracés sur l'éprouvette afin de pouvoir lui communiquer, avec exactitude, les allongements successifs et désirés "sens trame". Les réactions sens chaîne, ont été communiquées avec le dynamomètre et les forces mises en jeu enregistrées dans ce seul sens. Les valeurs des déformations enregistrées lors du décatissage réel ont servi de référence pour cet essai de simulation.

Les variations de force enregistrées, sens chaîne, au cours de ces différentes phases du rentoilage, sur éprouvette réduite, de 15 x 20 cm, sont représentées sur les courbes de la figure 2.

En conclusion, déformations et forces mises en jeu sont donc les suivantes :

	Déformations (allongement en % par rapport aux dimensions initiales)	Forces correspondantes sens CH en daN-mètre linéaire
Première mise en tension	7,61 % (CH) 0,22 % (TR)	≃ 317 daN m-1 (220 après relaxation)
Deuxième mise en tension	12,3 % (CH) 0,56 % (TR)	≃ 400 daN m-1 (266 après relaxation)
Troisième mise en tension	14,8 % (CH) 0,76 %(TR)	≃ 533 daN m-1 (353 après relaxation)
En fin de rentoilage	14,8 % (CH) 0,76 %(TR)	120 daN m-1

III - ANALYSE DU COMPORTEMENT DE RENTOILAGES A LA COLLE (FICTIFS) SOUS L'EFFET DE VARIATIONS CLIMATIQUES SIMULEES

Quatre rentoilages expérimentaux ont été réalisés pour cette étude. Ils ont été effectués en deux époques 1975 et 1977 à partir d'une même toile de doublage (voir tableau 1), avec les mêmes gazes et la même colle. Les seules différences ont porté sur les caractéristiques du tableau fictif et sur le taux de colle déposée.

Les caractéristiques des tableaux fictifs apparaissent dans le tableau 2 et celles du rentoilage dans le tableau 3.

III.1 - Méthodes mises en oeuvre pour apprécier les variations dimensionnelles des éprouvettes et les phénomènes de relaxation et de recouvrance des éprouvettes tendues à longueur constante

Ces essais ont été conduits sur des éprouvettes prélevées par découpes sur les rentoilages.

Les tests développés à l'INSTITUT TEXTILE DE FRANCE (9 - 10), mettent en oeuvre une enceinte climatique capable d'effectuer un certain nombre de variations simultanées de température et d'humidité relative, et des supports d'échantillons adaptés aux mesures envisagées.

TABLEAU 2

Caractéristiques des "tableaux fictifs"		
	Essais 1975	Essais 1977
P m2 toile non enduite	lourde	146,4 g/m2
P m2 toile enduite	451 g/m2	602,7 g/m2
% enduction	faible ?	75,7 %
Compte en chaîne	23 fils/cm	12 fils/cm
Compte en trame	16 fils/cm	14 fils/cm
Titre fils chaîne	72 Tex	53 Tex
Titre fils trame	54 Tex	54 Tex

Nota: Le tableau fictif 1977 est donc beaucoup plus lourd, mais seulement du fait de la couche d'enduit déposée : la toile en elle-même est très ouverte et équilibrée (petits fils et peu nombreux) en comparaison de la toile utilisée en 1975 très close et plus déséquilibrée (gros fils et nombreux). Toile du commerce.

TABLEAU 3

Paramètres	Caractéristiques des rentoilages à la colle française 1975-1977			
	1975 * sans gaze	1975* avec gaze	1977 sans gaze	1977 avec gaze
P m2	1055 g/m2	1330 g/m2	1094 g/m2	1399 g/m2
P m2 toile à peindre enduite	451 g/m2	451 g/m2	603 g/m2	603 g/m2
P m2 gaze		75 g/m2		75 g/m2
P m2 toile doublage	349 g/m2	349 g/m2	349 g/m2	349 g/m2
Taux de colle	25,4 %	35,2 %	13 %	26,6 %

* Ces deux rentoilages ont été préparés ensemble sur le même châssis, donc sur la même toile "décatie".

Les supports sont équipés de capteurs de déplacement et permettent de suivre, en continu, sur enregistrements :

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- soit les variations de dimensions d'échantillons libres de s'allonger ou de se rétrécir sous l'effet des variations d'humidité (exprimées en % de la longueur initiale : ΔL %)

- soit les variations de force qui affectent les éprouvettes préalablement tendues sur le support à un niveau de tension fixé à priori oF = 10 daN m-1 (exprimées en % de cette tension initiale : ΔF %).

Pour la conduite de ces essais, les cycles ont été choisis de la manière suivante : 20° - 65 % HR (conditions de références) ; 10° - 35 % HR (8h) ; 10° - 90 % HR (8h) ; 40° - 35 % HR (8h) ; 40° - 90 % HR (8h) ; 20° - 65 % HR (8h).

III.2 - Résultats

Les résultats de ces mesures ont été représentés schématiquement par les courbes des figures A à E.

III.2.1 - En ce qui concerne les seuls tableaux fictifs (Fig. A et B) on constate :

- que leur comportement en fonction des variations d'ambiance est sans anomalie, à savoir, rétraction et recouvrance à chaque transition humide-sec, allongement et relaxation à chaque transition sec-humide : cette évolution se faisant en fonction des cycles successifs, de manière assez "centrée" autour des caractéristiques initiales de référence

- que le tableau 1975, préparé sur toile serrée, avec peu d'enduit, s'avère assez passif vis-à-vis de l'ambiance

- que le tableau 1977, préparé sur toile ouverte, avec beaucoup d'enduit s'avère très nerveux (fortes amplitudes des variations dimensionnelles et écarts de tension très marqués à chaque transition)

- que les deux tableaux se détendent complètement aux conditions humides (aussi bien sens chaîne, que sens trame).

III.2.2 - Rentoilage traditionnel à la colle sans gaze (fig. C)

L'examen des courbes de variations dimensionnelles révèle un retrait important du rentoilage, dès le passage au premier cycle humide (10° - 90 % HR). Ce comportement est donc en désaccord avec celui noté avec les tableaux fictifs, ou avec les toiles de lin en général, qui s'allongent sous l'effet d'une humidité relative croissante et se rétrécissent au sec. Il n'est pas probable que l'encollage déposé sur la toile puisse être à l'origine d'une telle anomalie de comportement.

Il faudrait donc admettre dans ce cas, que la toile (en lin) de doublage ayant subi de fortes déformations lors du "décatissage"

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relaxerait au premier cycle humide, une partie des tensions accumulées, en se rétractant de plus de 4 %. Ce phénomène est plus prononcé en chaîne qu'en trame, ce qui apparaît en accord avec les déformations communiquées au décatissage.

Les cycles suivants (40° - 35 % ; 40° -90 % ; etc..) provoquent de nouvelles variations dimensionnelles, mais moins accentuées. Le premier retrait impose donc, dès l'origine, une "dérive" des dimensions vers une rétraction.

L'allure des courbes de tension des éprouvettes tendues est tout-à-fait en accord avec la tendance à la rétraction notée ci-dessus. L'accroissement de tension sur l'éprouvette initialement tendue à 10 daN-mètre linéaire, atteint 600 % au premier cycle humide. Il faut attendre les conditions 40° - 90 % HR pour que les accumulations de tensions se dissipent et que l'éprouvette retrouve approximativement l'état initial. Une nouvelle surtension est enregistrée au cycle suivant, plus sec (20° - 65 % HR). Il est donc intéressant de noter que, compte tenu du comportement de ce rentoilage, la tension initiale ne se relâche jamais et que les éprouvettes n'atteignent pas des états de surtensions rédhibitoires comme ce sera le cas avec d'autres échantillons.

Rentoilage à la colle avec gaze (fig. D)

On peut remarquer cette fois, que les variations de dimensions des éprouvettes sont beaucoup plus limitées et surtout qu'elles ne présentent aucune anomalie : allongement aux cycles humides, rétraction aux cycles secs.

Si les variations dimensionnelles sont faibles, par contre les surtensions et les "à coups" de tensions sur les éprouvettes sont très importants (pouvant atteindre 1700 %) : de telles variations de tension devraient évidemment être supportées par le châssis.

Il semble donc que la réaction intrinsèque de la toile de doublage ait été bloquée par une bonne efficacité du collage (forte couche de colle, perméabilité réduite par les gazes, etc...) et que le comportement du composite complexe que constitue ce rentoilage soit plutôt induit par celui de la toile à peindre (avec un facteur amplificateur lié au caractère hydrophile de la colle déposée).

III.2.3 - Rentoilage 1975 (fig. E)

Seuls ont été représentés les comportements d'éprouvettes prélevées sens chaîne dans les rentoilages avec et sans gazes. Dans cette expérimentation, une seule condition diffère de celles retenues pour les autres essais, à savoir : le premier cycle humide 10°-90 % HR a été supprimé et remplacé par une transition moins brutale. A l'examen des courbes on peut constater, une nouvelle fois, et pour les deux rentoilages que le passage à la condition réellement humide (40° - 90 % HR) libère les contraintes internes de la toile de doublage avec apparition d'une anomalie (retrait et recouvrance) alors que le comportement avait été normal jusqu'à cette condition.

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III.3 - Discussion des résultats

De l'analyse de ces divers résultats on pourrait dire, en ce qui concerne ces rentoilages à la colle sur lin "décati"

- tout d'abord, que la toile "décatie" n'est pas inerte vis-à-vis de l'ambiance et qu'on pourrait lui attribuer les anomalies de comportement. Le "rôle" de "maintien" qu'on lui accorde pourrait justement être dû à sa tendance à se rétracter et il est d'évidence que sur une toile "décatie" les tableaux sont maintenus et que l'on ne rencontre plus les détensions complètes et systématiques à chaque condition humide, ainsi qu'elles ont été enregistrées avec les seuls tableaux fictifs

- ensuite, que les tableaux fictifs, suivant la contexture de la toile et la quantité d'enduit déposée, peuvent avoir des comportements extrêmement différents. De plus, suivant la quantité de colle et la présence ou non de gaze, les comportements du tableau fictif et de la toile de doublage dans le rentoilage risquent d'être ou non en synergie

- dans le cas d'un tableau fictif peu nerveux qui a justifié l'utilisation de beaucoup de colle en rentoilage, la "libération" des contraintes localisées dans la toile de doublage se ferait très progressivement (effet du collage, du rôle de filtre joué, vis-à-vis de l'extérieur, par une contexture serrée). Il est intéressant également de souligner que dans le cas d'un tel "tableau fictif" l'utilisation de gaze et donc, d'une plus grande quantité de colle, ne change en rien le comportement du rentoilage

- dans le cas d'un tableau fictif très nerveux, rentoilé avec moins de colle la libération de l'action de la toile de doublage semble immédiate (faible collage, forte perméabilité avec l'extérieur du fait d'une contexture ouverte) au premier cycle humide. Ceci apparaît intéressant pour le bon maintien du tableau, sans atteindre sur l'ensemble du rentoilage tendu des états de surtension trop importants. Par contre, ici l'effet de rentoiler avec gaze et plus de colle permet de "contenir" les réactions anormales de la toile de doublage et semble-t-il d'assurer une cohésion et une rigidité suffisantes pour atteindre les conditions de synergie de comportement entre toile de doublage (maintenue) et tableau fictif. On constate alors un comportement normal du rentoilage en fonction des transitions sec-humide, mais des états de surtension extrêmement importants peuvent alors être atteints (rentoilages rigides) ainsi d'ailleurs que des détensions complètes.

Le rôle de la colle à la fécule est certainement celui d'un renforçateur de l'action de l'humidité (à la fois par sa capacité d'adsorption d'eau et ses possibilités de fluage par cisaillement aux fortes HR) car dans le cas où l'Alcamer est utilisé, l'intensité des réactions du rentoilage est beaucoup plus limitée (voir courbes de la fig. F).

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Enfin, comparativement à l'ensemble de ces résultats, il est intéressant de situer le comportement d'un rentoilage à la cire-résine (même toile de doublage et tableau fictif 1977). Sur les courbes de la fig. G, il faut noter les très faibles variations dimensionnelles des éprouvettes, qui témoignent d'une grande intertie du rentoilage vis-à-vis des changements d'ambiance (rôle d'écran joué par la cire-résine). Les éprouvettes tendues conservent leur tension et n'acquièrent pas de surtensions supérieures à 150 % en moyenne. Les transitions isothermes (10° ou 40°) n'entraînent pas. comme pour les précédents rentoilages, de brutales variations de tension sur les éprouvettes : on observe soit une constance de l'état de tension (à 10° C), soit une lente diminution (à 40° C) en fonction de l'augmentation de l'HR.

IV - CONCLUSION

Les résultats acquis dans ce travail sont surtout valables pour un tableau "fictif" très "nerveux" dans son comportement. Il conviendrait donc une approche nouvelle de ce problème, d'étudier la "réaction" de toiles anciennes sous l'effet de variations d'ambiance simulées et comparativement de suivre in situ, les réponses de tableaux "rentoilés" ou non.

Cette expérimentation a montré que le décatissage du lin ne peut être simplifié et doit absolument être double pour que cette opération atteigne l'effet recherché d'amélioration de la stabilité dimensionnelle ; que l'encollage d'une toile serrée est plus abondant que celui d'une toile lâche ; que la présence d'une gaze exige presque le double de colle et qu'elle augmente la solidarisation du tableau fictif et de la toile neuve et peut rendre le rentoilage très rigide. Si la comparaison sous l'angle de la stabilité en fonction des variations de climat du rentoilage français à la colle avec le procédé à l'Alcamer et la cire-résine amène à préférer ces derniers par contre, il faudrait prendre en considération la faculté de reprendre les déformations, la résorption d'un réseau prononcé de craquelures et la "réversibilité" ou possibilité de reprendre un rentoilage pour un autre de son choix, tous domaines où les procédés aqueux gardent des qualités indéniables.

NOTES

1 - Rentoilage à la colle de pâte française

Colle 3 kg farine de blé
1,5 kg farine de seigle
0,75 kg de colle de peau
533 g de térébenthine de Venise
66 g d'acide phénique

pour 8 litre d'eau.

(45 % d'extrait sec).

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H.J. PLENDERLEITH and S. CURSITER, The problem of lining adhesives for painting : wax adhesives. Tech. St. Vol. III, n° 2, Oct.1934

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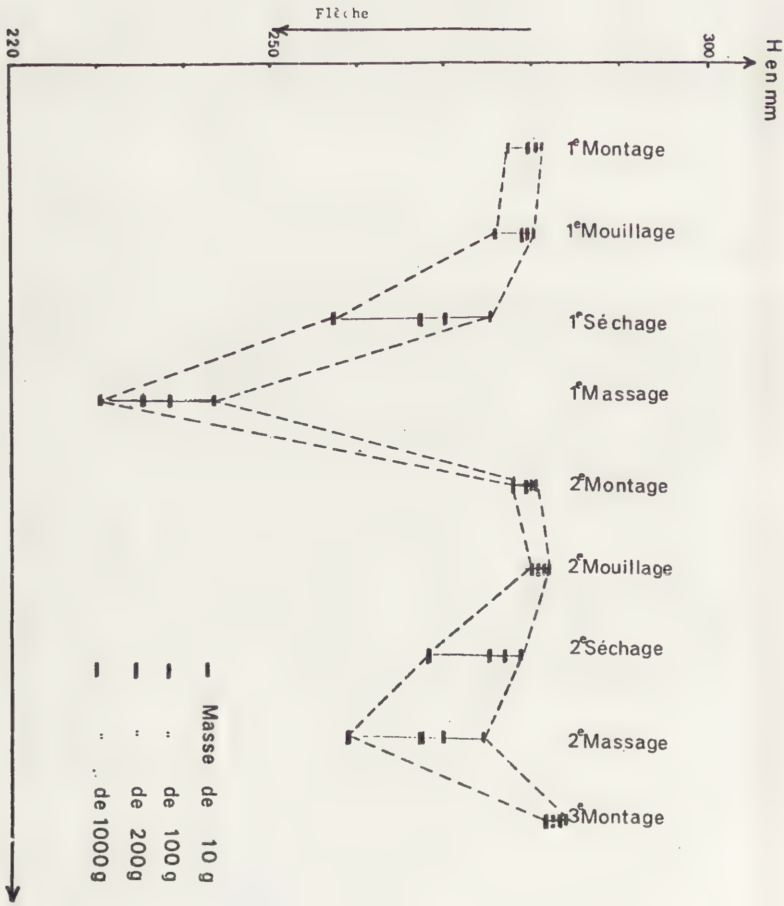

Flèche
220
250
300
H en mm
1e Montage
1e Mouillage
1e Séchage
1e Massage
2e Montage
2e Mouillage
2e Séchage
2e Massage
3e Montage
Masse de 10 g
" de 100 g
" de 200 g
" de 1000 g

Fig. 1

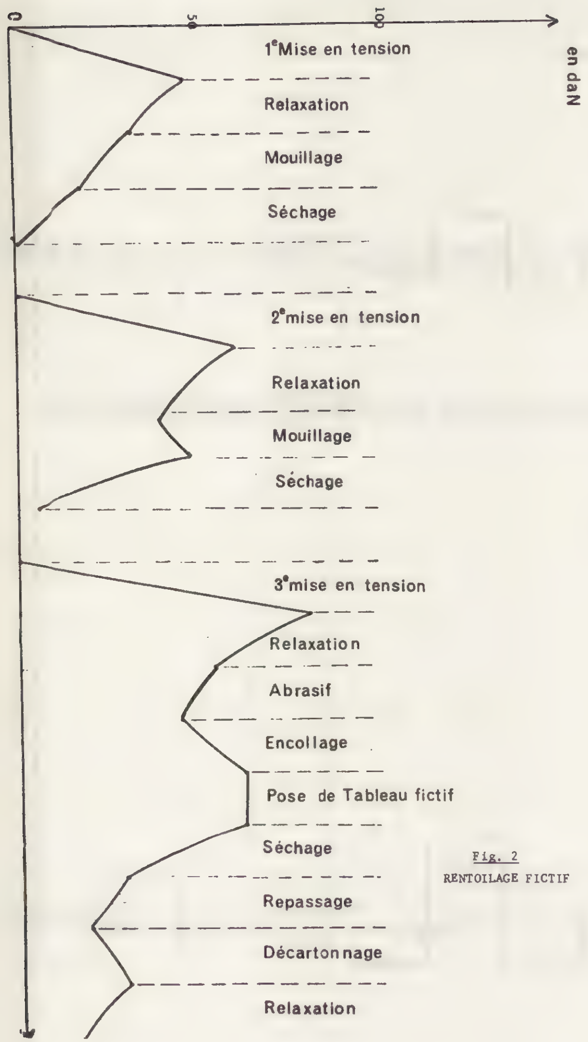


Fig. 2
RENTOILAGE FICTIF

Tableau fictif 1975

FIGURE A

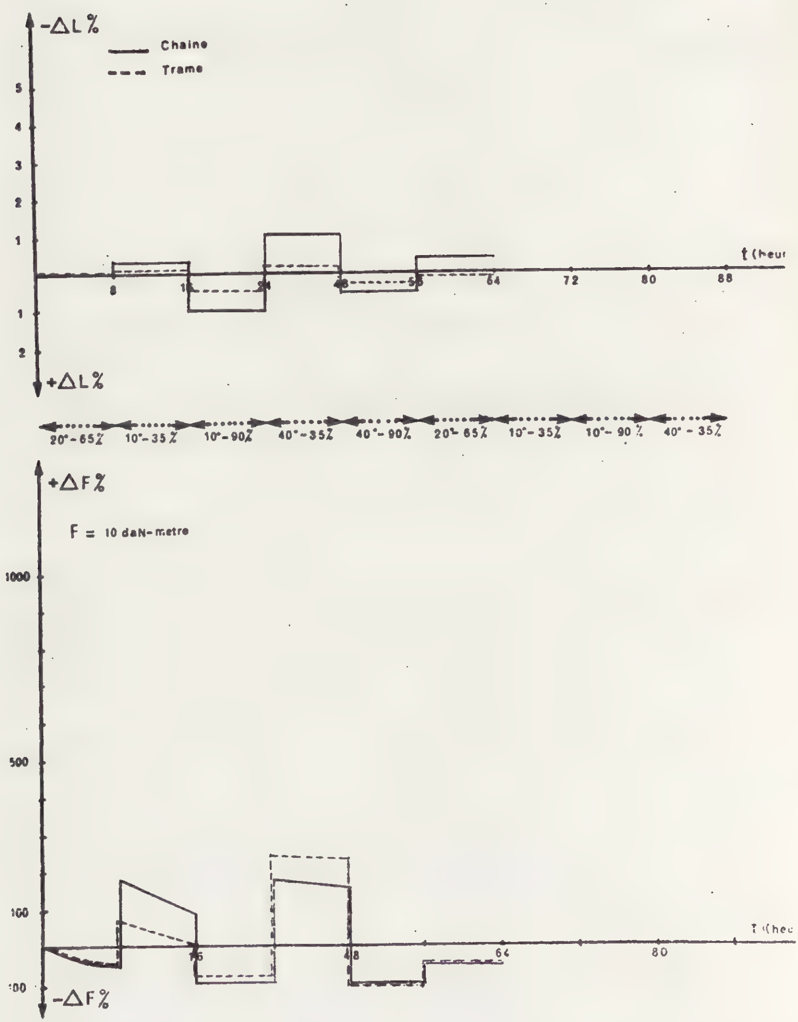
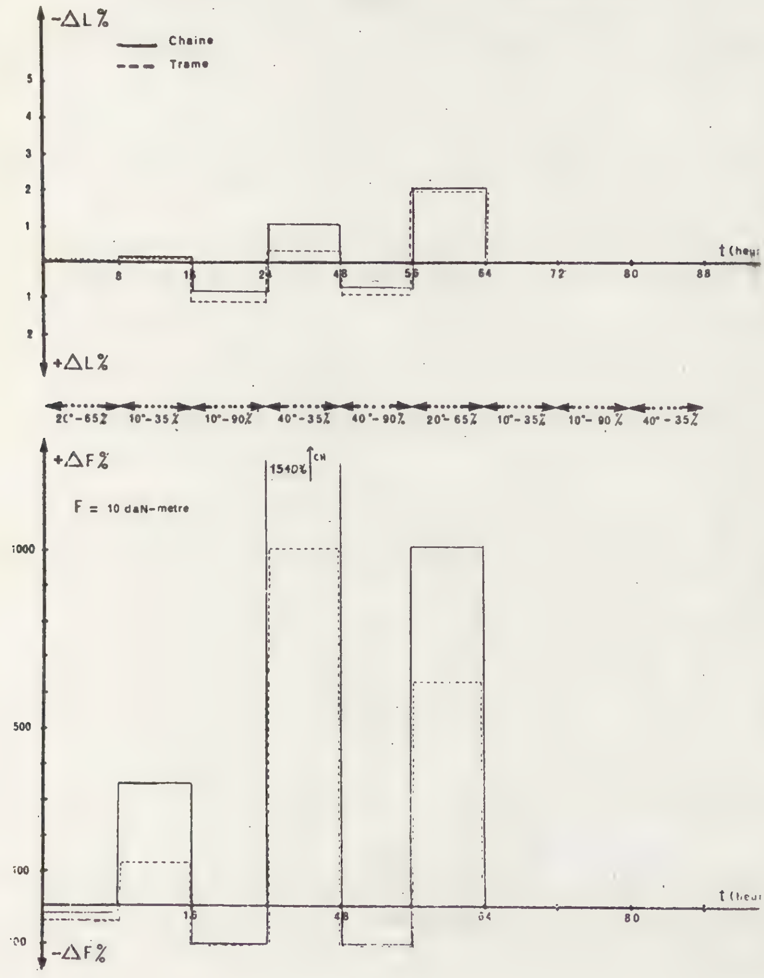


Tableau fictif 1977

FIGURE B



Colle française sans gaze

FIGURE C

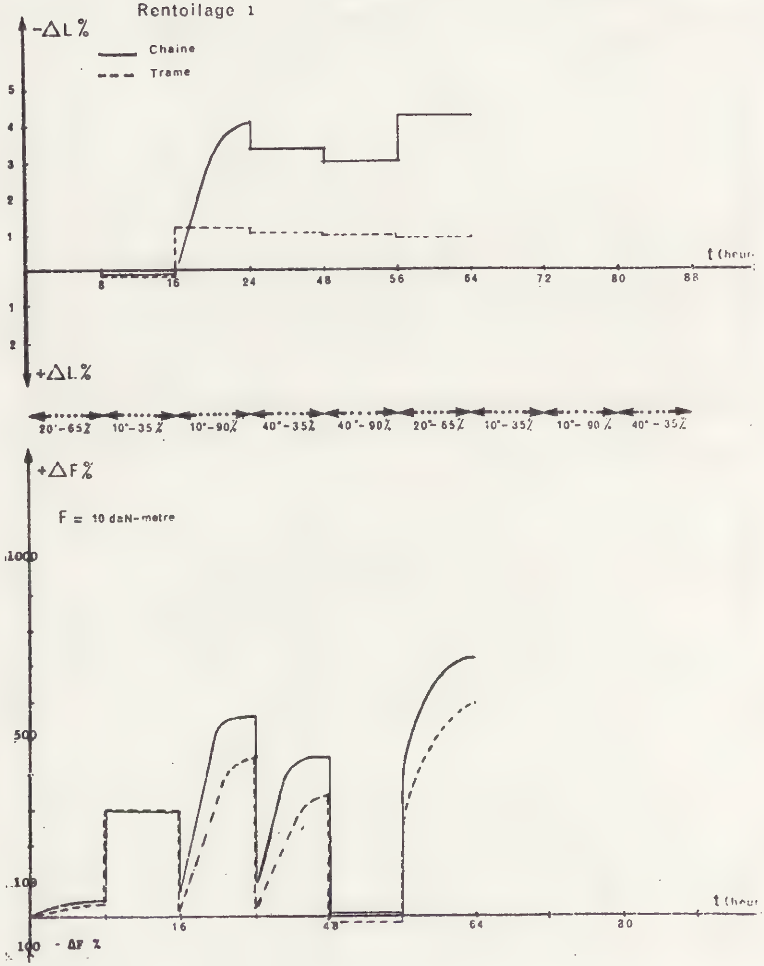
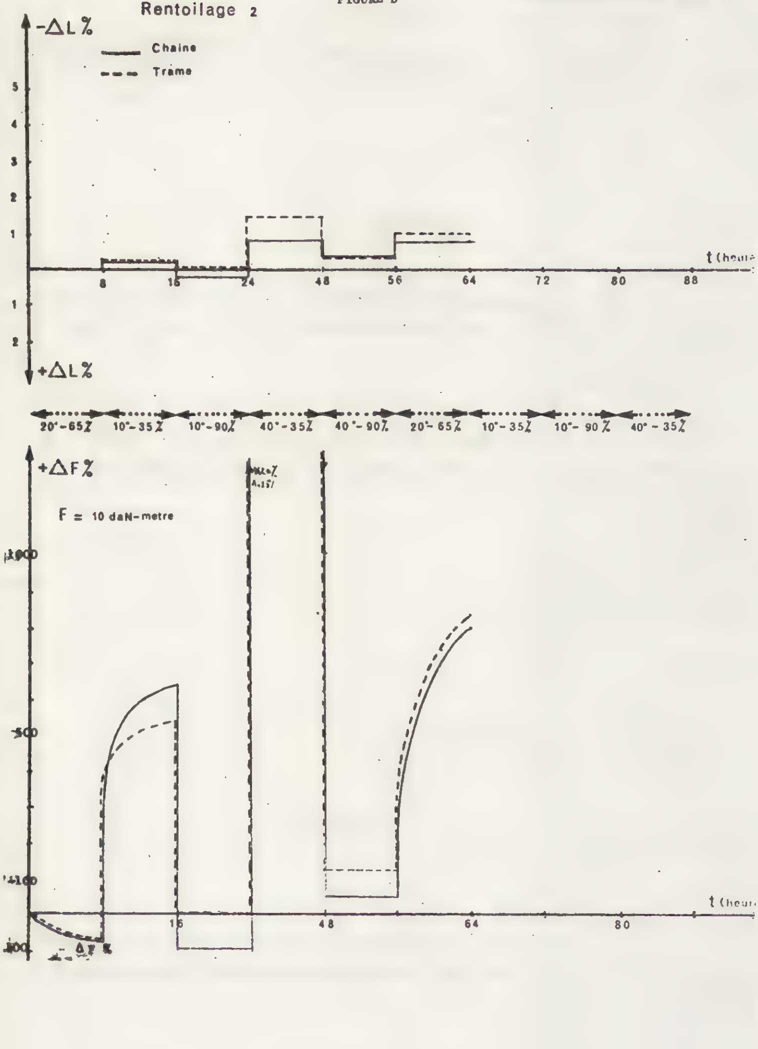


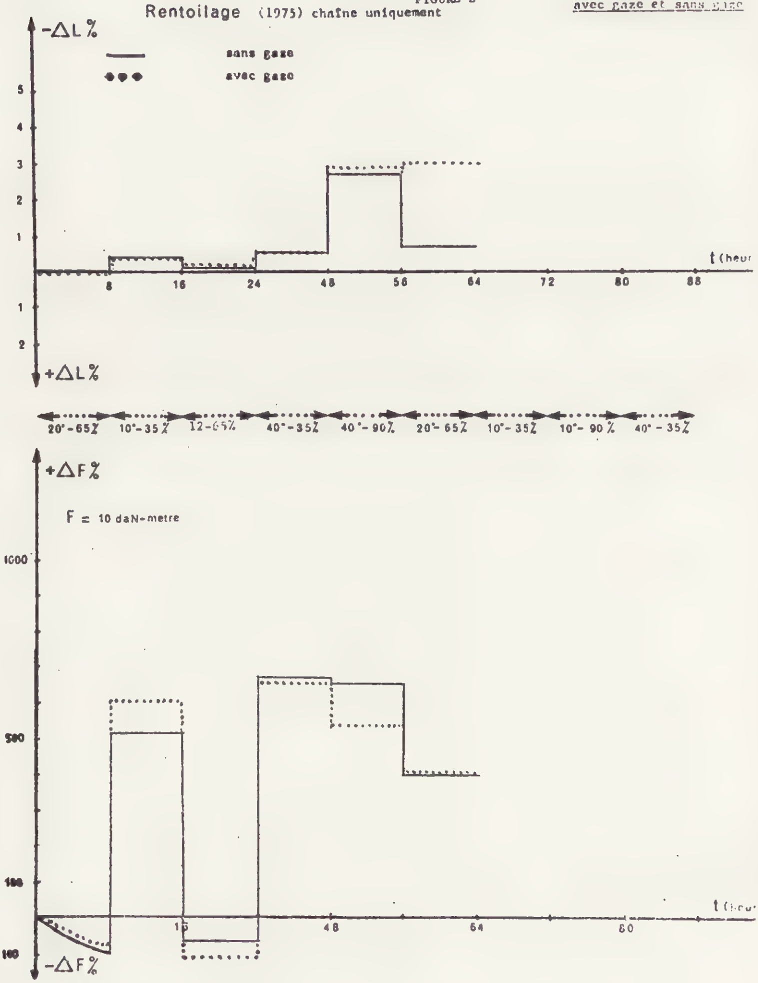
FIGURE D

Colle française avec gaze



Colle française (1975)
avec gaze et sans gaze

FIGURE E



Alcamer avec gaze

FIGURE F

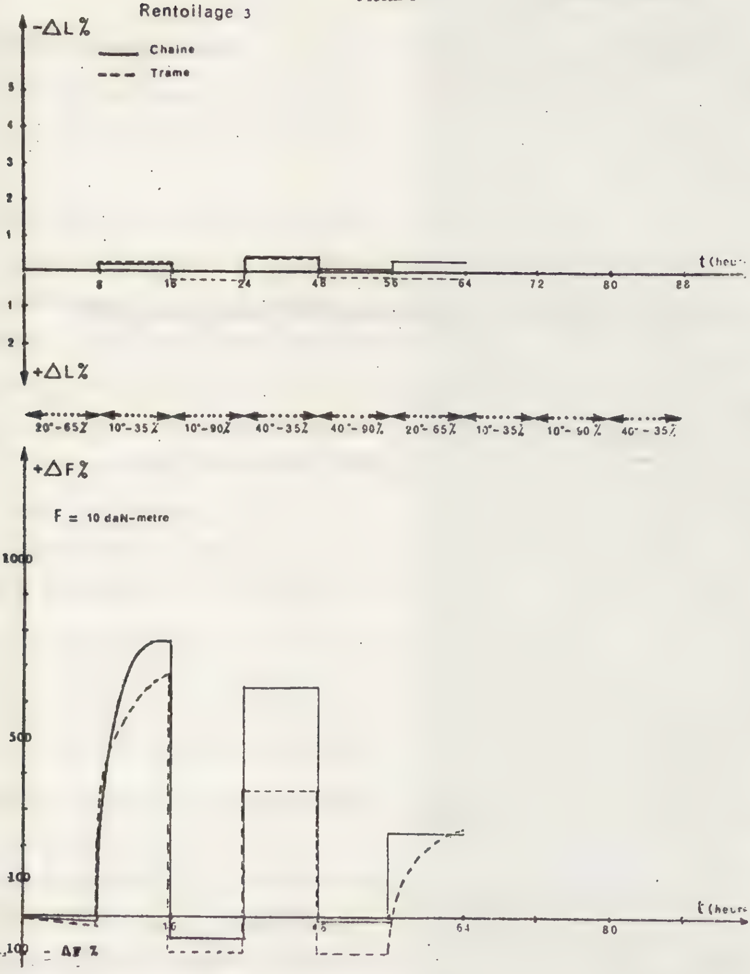
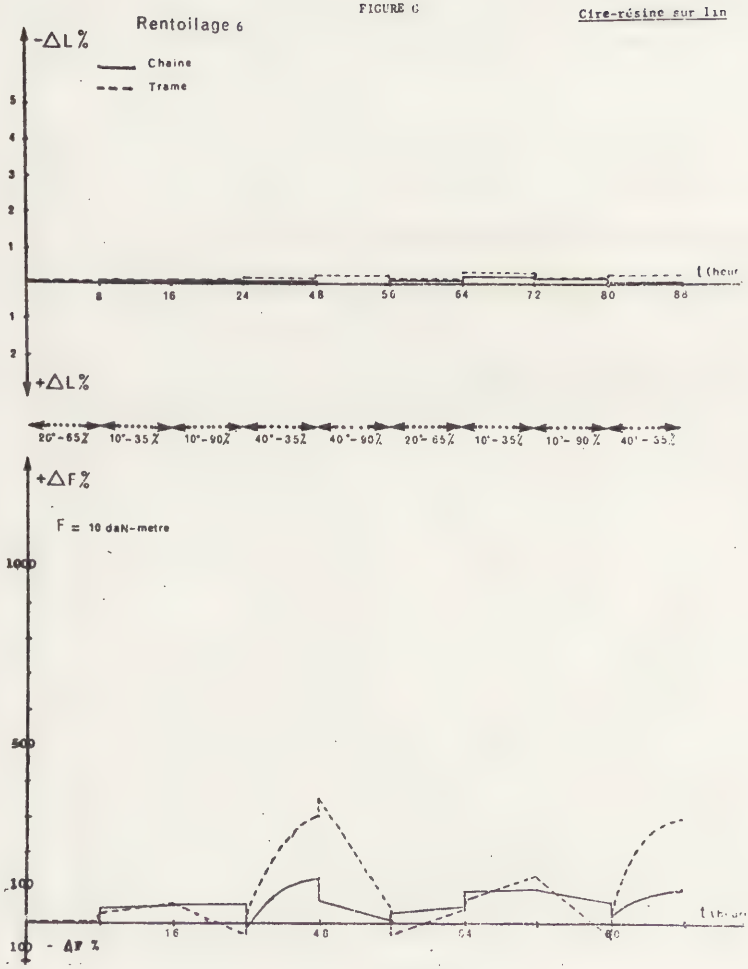


FIGURE 6

Cire-résine sur lin



THE HISTORICAL SITUATION OF PICTURE RELINING IN VIENNA

Detlev Kreidl

Abstract:

The report deals with the history of relining at the Kunsthistorisches Museum in Vienna.

The history of picture relining in Vienna is closly connected from its beginning with the history of the former Gallery of the Emperor, now Gemäldegalerie of the Kunsthistorisches Museum. Only here works of art and the reports of their restoring have been preserved for such a long period. Out of these reports it is possible to gain knowledge of picture restoring in the past. In relation to these reports it is possible to study the results of the methods on the pictures itselves.

The Gemäldegalerie has its main roots in the collections of the members of the Habsburg Family in Prague and Tyrol as well as in those of the Austrian governors of the Netherlands - first of all in the Picture Gallery of Archduke Leopold Wilhelm. In connection with the individual collections one can find from time to time documented notes contending remarks on restoring. One seldom finds more than names of the persons and the money that was spent for the restoring work. Nevertheless the documents make clear that the curators of the pictures galleries were painters who were obliged first to do artistic work. One needs not consider the historical changes of the administration but it may be remarked that up to the retirement of Eduard von Engerth in 1892 only painters were responsible for the preservation of

the pictures in the Imperial Gallery [1].

This situation in Vienna remained quite the same for a long time though a school for restoring had been founded in 1867 by Erasmus Engerth. It was connected to the Imperial Gallery; the portraitpainter Franz Eybl was the first teacher there[2].

Not until the Meisterschule für Konservierung und Technologie at the Academy of Fine Arts was established by R. Eigenberger in 1935 a change took place [3].

Relining methods:

The description of methods for picture restoring has three sources.

1) Restored pictures with inscriptions connected to the restoration.
2) Descriptions of the pictures in the inventory of the collection and restoration reports.
3) Verbal information by the elder generation of restorers.
   In connection to this one might consider that without the descriptions done by Theodor von Frimmel we would knowless about restoring methods of the nineteenth century in Vienna [4].

Marouflage.

One of the oldest reports in the question of preserving pictures on canvas may be seen in the description of Tizian's "Kirschenmadonna" in the inventory of the collection of Archduke Leopold Wilhelm in 1659. The short remark "Ein Stuckh von Ölfarb auf Leinwath und auf Holcz gepabt..." [5] tells, that in this time Tizian's painting (Inv. No. 118) was fixed on panel.

The marouflage method was also practised on Giorgione's "Laura" (Inv. No. 31) and is still preserved in the same con-

dition like several other pictures of the collection.

Ironing.

The use of this method is guaranteed by the activity of the painter Joseph Hickel in the Imperial Gallery. Hickel was restorer of the gallery between 1772 and 1776. After that time he became in honor to his artistic ability an official painter at the court [6]. Up to our time there are still conserved two relinings, which bear the signature of Joseph Hickel and give knowledge of the relining method of his time.

Jacob de Backer: Mary with the child and St. John.
Inv. No. 1689

Italian Painter: St. Jerome. Inv. No. 1877

On the back of both pictures one can still sead the handwritten remark "Hickl Rep. 1774". The relining material is thin and loose woven and was ironed from the back. The layer of paste is extremly thin and penetrates the relining material.

This method had been used for long time. At the end of the nineteenth century the use of a thick and compact woven relining material together with thick layer of paste can be observed.

A correct description of this relining system is given by Th. von Frimmel [4].

Rentoilage.

Between 1853 and 1858 Tizian's "Kirschenmadonna" was transferred from canvas to wood by Erasmus Engerth. One might say that this procedure was a marouflage but the working method corresponded to that of the rentoilage. An exact description of the rentoilage and its historical aspects is given again by Th. von Frimmel [4]. In connection with the restoringof Tizian's "Kirschenmadonna" it is interesting to

hear about the refusing position which Peter Krafft held, than director of the gallery. The document with Peter Krafft's opinion was published by Eugen von Rothschild in 1932[7].

The refusal of the rentoilage has been preserved in Vienna up to our time. On the other side the restorers tried to develop and refine a relining system, which bears the german term "Kaltpreßverfahren" and may be described as

Cold pressure relining.

There is no written evidance of the beginning of this method. Since 1900 facing (tissue paper or sice paper) was common to protect the loose color of a picture on canvas. Afterwards the picture was impregnated from the back with varnish. After a time of drying this procedure was followed by an impregnation of the back with hot paste mixed with Venitian terpentine on which the relining canvas was put. The drying of the paste took place in a veneer press between warmed boards. This system reminds of the working methods of the joinery.

Between 1920 and 1930 the arthistorian R. Eigenberger concentrated his interests on restoring and specially on relining pictures. His efforts were directed to a simple method to conserve as much as possible of original structure and texture. The result of Eigenberger's effort are part of E. Stöbe's report of "Picture relining with the veneer press".

One of the first students of Eigenberger, F. Sochor, transferred that method (cold pressure relining) to the Restaurierwerkstätte der Gemäldegalerie des Kunsthistorischen Museums in Vienna. In this time padding was only used for the surface of the painting. On the back there was only used cotton textile to prevent the relining from beeing stuck to the boards of the veneer press.

Between 1964 and 1965 E. Stöbe and D. Kreidl made a research at the Meisterschule für Konservierung und Technologie at the Academie of Fine Art to find out the effectiveness of the known relining methods. During variing the different possibilities there could be noticed that padding from both sides showed the smallest change on the pictures surface. On the other hand the research revealed the limits of the method which could be observed in case of extreme impasto of modern paintings. In a special case, when a picture by Herbert Boeckl, Austrian painter who died in the sixties, had to be relined, the high impasto was protected by Styrofram.

The development of the relining systems at the Kunsthistorisches Museum shows a principal fact. Though relining with wax ws at least practised in Vienna by E. Gerisch since 1896, there had never been an other method in use than relining with paste.

<u>Notes:</u>

1) For the history of the Kunsthistorisches Museum compare: Alfons Lhotsky, Festschrift des Kunsthistorischen Museums zur Feier des fünfzigjährigen Bestandes. Die Geschichte der Sammlungen, I/II, Vienna 1941-1945.

2) A. Lhotsky, loc. cit. p. 559.

3) Walter Wagner, Die Geschichte der Akademie der bildenden Künste in Wien, Vienna 1967, p. 305.

4) Theodor von Frimmel, Handbuch der Gemäldekunde, Leipzig 1904.

5) Jahrbuch der Kunsthistorischen Sammlungen des A.H. Kaiserhauses, Fol. I, p. XCV, No. 161.

6) A. Lhotsky, loc. cit. p. 419.

7) Eugen von Rothschild, Tizians "Kirschenmadonna", Belvedere, 11, 1932, p. 107-116.

COLD-LINING AND THE CARE OF THE PAINTLAYER IN A TRIPLE-STRETCHER SYSTEM.

ALSO: ANSWERS TO SOME QUESTIONS AND DOUBTS ABOUT THE COLD-LINING SYSTEM

V.R. Mehra

In 1969 the Central Research Laboratory for Objects of Art and Science in Amsterdam began studies in order to find better methods and more suitable materials for the lining of canvas paintings. Since then a substantial amount of experimental work has been done. In the early 70's this resulted in what is now called 'cold-lining', a process which, until now, has received quite some attention from colleagues all over the world who realise also that the traditional wax-resin and starch-glue linings leave much to be desired.

We started our research in cold-lining with more hope than belief and we ended it with more belief than we could have hoped for. The experimental stage has been left behind and, as we presently believe, cold-lining has become to us a matter of fact, a way of handling time-worn canvas paintings confidently, safely and gently, with the help of means which ensure thorough conservation and also preservation of all characteristics which determine the nature of the painting concerned.

Until this day we have cold-lined more than a hundred canvas painting dating from the 17th century until the second quarter of the 20th century. Among them there were paintings with quite different characteristics, from thick, solid, high-impasto canvases to thinly done, flat and nearly transparent work. So far we experienced only on one painting adverse effects. This will be discussed later on in this report. Otherwise, in each lining the characteristics of a particular painting were preserved. This was observed by those colleagues and museum curators, art-historians and others related to the field, who visited us in Amsterdam,watched us work or worked with us to get the feeling of the cold-lining approach.

This sounds self-confident. But we do not believe to be over-confident. If anything, we now start wondering why, apart from the interest shown, there is rather little evidence of cold-lining being tried out by our colleagues independently, at home as well as abroad. We ask ourselves a question and we will have to try to find the answer as well. There may be two aspects to this: one concerning the fact that cold-lining is still a rather new method, the other one being relevant to the circumstance that there are clearly limita-

tions to what one can pass on in terms of information in the papers one writes on one's work. This may be of particular importance in this instance which involves in lining a clear-cut diversion from long-established practices.

As to its novelty, we do realise that cold-lining came into existence less than a decade ago; that much of the time which passed since we made a first move, was spent on experimental work and that the cold--lining method, which we finally got to believe in, originates from only one single institute. We would certainly not have expected colleagues all of a sudden to abandon the lining-methods which have been practised for two centuries, and wholeheartedly embrace this Benjamin among restoration techniques, involving methods and materials we were not at all familiar with until recently. Yet, we do find it somewhat strange that, at least to our knowledge, only a few colleagues seem to have tried to put cold-lining to the test merely as an experiment. That is strange in view of the fact that in the past two decades particularly, there has been wide and ever increasing concern over the disadvantages of conventional lining-systems in terms of preserving a painting's properties. Indeed, 'liners' all over the world get more and more worried, yet so many of us continue to contend themselves with that which is precisely the cause of our concern.

As to the limited cogency in publications on one's work, it is obviously there. At the same time we may have to concede that we were probably not clear enough on all aspects described in our papers so far. One aspect - treatment of a damaged paintfilm and/or a distorted canvas - was hardly at all dealt with by us. There is a simple reason for that. At the time we wrote our most recent paper on cold-lining (for the ICOM-conference 1975) we were still busy experimenting. Nothing was conclusive. We shall deal with it now further on in this paper.

Review of reactions and comment

We first introduced cold-lining with a paper presented at the ICOM-conference held in Madrid, Spain, in 1972. In 1974 there was another paper, this time on new developments; it was presented at the International Conference on Comparative Lining Techniques held in the Maritime Museum, Greenwich, England. Part of the development was the construction of what we termed a "Low-pressure cold-lining table", a contraption which further facilitates the cold-lining process and may be an answer to the hot-table in wax-lining. This is at least what we would like it to be. A proto-type of this table was taken along to Greenwich, and there we demonstrated its workings to an audience which, understandably, could do little else but show a keen interest, without being carried away by conviction entirely. In 1975 we wrote another paper, again on further developments in the cold--lining system, and this time for the ICOM-conference held in Venice. There we also showed a film on cold-lining, meanwhile produced at the laboratory in Amsterdam. In the same year we published, at request, a summary of our studies and its results in the West-German periodical "Maltechnik-restauro")2,1975).

Throughout the years, response from colleagues ranged from a display of sceptic surprise to obvious feelings of enthousiasm and approval. The latter gradually gained ground along te way. This we have observed particularly in the years passed since the ICOM-conference of 1975. We assume that the showing of our film on cold-lining in Venice, where many colleagues were present, had a clarifying effect. Correspondence with colleagues increased markedly and several of them came to Amsterdam to see cold-lining in practice and to seek answers to questions. From those questions and from the discussions which came in their wake we learned that, however hard one tries to write one's papers as clearly and as simply as one can, there is always room left for misunderstanding. We also learned that many colleagues are reluctant to act by words alone. They want to see for themselves how cold--lining works; they are willing and eager to try it out from beginning to end, but they hesitate to do that on their own. Yet,we feel that cold-lining should be put to the test in order to get the feeling of this new approach and to remove doubts and concern. In this context it may be useful to review here what concerned those colleagues who came to see us in Amsterdam about various aspects of our work.

1. There is a general concern with regard to the use of a synthetic resin as a lining-adhesive and the use of synthetic materials as lining-canvas, particularly with regard to reversibility;
2. There is misunderstanding as to the function of the screens through which the lining-adhesive is applied onto the lining-canvas;
3. There is fear that the moisture present in the lining-adhesive (Plextol B-500 emulsion) may have adverse effects on the painting materials (and the painting's canvas lined with that adhesive);
4. One wonders what is done in cold-lining about a damaged paintfilm (flaking, cupping etc.) and/or deformations in a painting's canvas.
5. One wonders if it is possible to use cold-lining materials different from those mentioned in earlier papers.

ad 1. Use of synthetic adhesive and lining-canvas

There still is a profound prejudice against the use of synthetic materials in the restoration of canvas paintings. Synthetic materials have been in use for many years in the restoration and conservation of all kinds of art-objects of archaeological or historical value. Many restorers active in the various conservation fields will acknowledge that synthetic materials may have considerable advantages over natural materials. For some inexplicable reason, though, synthetic materials are still widely considered incompatible with the restoration of paintings. The reason may be that, among the wide range of different art-objects, paintings seem to have an aristocratic status of their own, which is, by the way, just as inexplicable.
Anyway, we did not jump into the use of synthetic adhesive or consolidant, and synthetic lining materials, blindly. We actually did a painstaking research into the properties of all kinds of adhesives and fabrics which we thought could eventually do. We tested their compati-

bility with painting materials in every possible manner on trial--objects and dummies (see our ICOM-report 1975) and the issue of reversibility was of major concern. When we finally selected an acrylic methacrylate copolymer emulsion, like Plextol B-500 (Röhm & Haas, West-Germany), we did so because we had reason to be fully satisfied with its properties as a lining-adhesive, its behaviour under fluctuating climatic conditions, and, indeed, its reversibility, as employed in our lining-system and in combination with the materials we found suitable to serve as lining-canvas: woven polypropylene, polyamide and polyester fabric.
Reversibility is indeed an important aspect. Let us then, once more, recall that the adhesive in our method can only form a very thin film or a dotted nap-bond pattern (depending on the selection of screen) between the painting's canvas and the lining-canvas. If a cold-lining must be reversed eventually, there is no need to use solvents. The lining-canvas can be separated from the painting's canvas by gently pulling it off at one or more corners and stripping it towards the centre, while the painting's canvas is held flat down on an equally flat surface. It is a gentle operation; no real force is needed. We have performed it tens of times on trial-objects with different characteristics and we never encountered any difficulty. An interesting feature is certainly that, after reversion, hardly any residue of the lining-adhesive shows on the back of the painting's canvas, provided the adhesive was applied on the lining-canvas only.

ad 2. Use of the screen-system

Repeatedly we have been asked to elaborate on the use of plastic- or nylon screens in the application of the adhesive onto the lining--canvas. This is quite simple really. In a general sense the use of the screen-system provides us with means to apply any selected adhesive in any selected quantity in a perfectly controlled manner and with all-over homogeneity in amount and thickness of the adhesive. It should be noted here that, however carefully one applies adhesive directly on a lining-canvas, either with a brush or a roller, perfect homogeneity can never be attained, nor will it thus be possible to determine the exact quantity of adhesive distributed. Application of adhesive through a screen allows for a very precise determination of the quantity and thus also of the cohesive strength required. It is the measure of permeability (amount of perforations, their size and thickness of the screen) which determines that quantity, and the variations are nearly inexhaustible. As pointed out in our previous papers: a thinly painted, finely woven canvas may, in a lining, need far less cohesive strength (thus less adhesive) between it and the lining-canvas, than a thickly painted, coarse painting-canvas material.
There is also some misunderstanding with regard to the function of the dotted pattern which is produced by applying the adhesive through a screen with a system of widely dispersed perforations. Some colleagues wonder if the dotted pattern will not show on the surface of a certain kind of painting, for example on a painting with a very thin paintfilm and also an extremely fine, thin painting-canvas.
It is true. On such a painting the dotted pattern might show in the

surface-texture. But one should not forget that we are not at all dependent on the dotted pattern. Also with the use of a screen one can obtain on the lining-canvas a smooth, closed film of adhesive, with homogeneous thickness. It really all depends on the kind of screen one uses. Dots of adhesive passed through very closely set perforations will link up as soon as the screen is removed from the lining-canvas and thus form a closed film. Also the use of curtain--net fabric (vitrage) will give a perfectly homogeneous film of adhesive. It is easily available and inexpensive. In our ICOM-report 1975 we added a picture of such material to a set of four illustrations of screens used by us. We must concede, though, that we did, unfortunately, not make a point of this possibility in writing.
Finally one may ask why we select dotted patterns at all if with the use of certain screens, a closed film of adhesive can be obtained as well. The answer is that in most cases a closely locking film of adhesive between painting-canvas and lining-canvas is not needed. The amount of cohesive strength needed to make a painting-canvas interlock with a lining-canvas firmly, is generally overestimated. A dotted pattern means decrease in the use of adhesive and increase in reversibility. It is interesting to note here that in cold-lining, with the dotted- or nap-bond system,generally not more than a fifth or a sixth part of the surface area of painting-canvas and lining--canvas is covered with adhesive. Yet,the cohesive strength between the canvases proved to be sufficient in tests of shear- and peel-off strength (see Tables in our ICOM-report 1975).

ad 3. Moisture content in the adhesive

That some colleagues feel concern over the fact that the lining adhesive in cold-lining is water-based, is quite understandable and justified. This has been of major concern to us from the initial stages of experimental work; and we have continuously tried to find ways to reduce that moisture content, until we finally succeeded to the point where it may be considered negligible, particularly as compared to the amount of moisture present in starch-glue.
Our concern got substance in 1974 when a cold-lining we did on a 19th-century English painting led to contraction of the canvas and damage to the paintfilm. It is the only mishap we have had in cold-lining, yet we feel it to be our duty to report it.
After the accident, which upset and discouraged us for a while, we made drastic changes in the adhesive application-method.
In our reports written for ICOM-Madrid 1972 and Greenwich -1974 it says that we dilute the emulsion with water when we seek reduction of the content of resin, thus reduction in cohesive strength in the emulsion. The report written for ICOM-Venice 1975 shows the change. We never again diluted the emulsion. In order to obtain reduction in cohesive strength, when so desired, for the lining of a particular painting, we learned to make use of mechanical means. On the one hand we may reduce the amount of resin by increasing the volume of the emulsion through addition of, for example, Saran-microspheres (see ICOM-report 1975), on the other hand we introduced the nap-bond (dotted) screen-system, which, as discussed above and in our ICOM--report 1975, allows for any selected amount of adhesive distribution

between painting-canvas and lining-canvas, and thus for any chosen measure of cohesive strength, and likewise also for reduction of moisture brought in contact with painting materials.
Moreover, we developed a method of pre-stretching a painting to be lined. This pre-stretching counteracts any tendencies of shrinkage of a painting-canvas and/or other materials which may be part of a painting to be cold-lined. Details of the pre-stretching procedure shall be discussed further on in this report. Let us first answer the next question.

ad 4. Taking care of a damged paintfilm and/or canvas prior to lining

We were often asked what we do about cupping, flaking, blistering and other kinds of deformation in a paintfilm or in a painting canvas. As mentioned before, this aspect was not dealt with thoroughly in our previous papers. We give it attention now, while realising that it is hard to be precise and clear in writing about the handling of distortions needing as much feeling and experience as theoretical knowledge. After all, each painting has its own particular characteristics; damages and distortions in paintfilm or canvas have their own particular nature; each separate case may need its own separate treatment, whether or not such damage can be roughly catagorised as being flaking, cupping, blistering, etc. Every experienced restorer knows that. Therefore this aspect can be discussed only generally.

In taking care of damages, we distinguish two catagories of handling: treatment prior to, and treatment after removal of a painting from its own stretcher.
Treatment prior to removal from the original stretcher pertains to the kind of damage which may cause loss of paintfilm at the slightest touch, usually flaking of fragments of paintfilm which only barely manage to hold on to the ground, or to the canvas when no ground is present. Such damage is given immediate attention through application of a suitable adhesive. We usually employ Plextol-B500 (either diluted or thickened, depending on the kind of damage), bringing a tiny amount of the adhesive under a flaking, covering it then with a small piece of Melinex (polyester foil) and gently rubbing the affected area with a finger tip. The flaking is thus not touched directly.
Also tears are dealt with prior to removal of a painting from its stretcher. On the repair of tears much has been written. Methods and materials used are well-known. Results are, however, not always satisfactory. With the lapse of time a repaired tear may prove to be the cause of deformations in the painting-canvas, i.e. if a repair is done too rigidly, when the patch and the adhesive used behind the tear are too thick and too strong, over-all tensions in the canvas may become uneven and the absence of flexibility in the patched area may lead to new deformations in the canvas.

It is clearly flexibility in the repair of a tear which will prevent the occurrence of such deformations. We therefore use a non-woven, thin nylon fabric as a patch and Plextol B-500 as an adhesive (50% Plextol in water with the addition of one part of chalk and one part of micapowder). The adhesive is thinly applied on to the torn area; the area is then covered with a pre-cut patch of non-woven nylon fabric; this is then covered with a piece of Melinex (polyes-

ter foil) and on top a sandbag (or loose sand) is placed. The adhesive will dry in about a day.
Treatment after removal from the stretcher sets in with a new development: pre-stretching. It is a method which is in use with some colleagues practising wax-resin or starch-glue lining. We have adopted it but had to amend it to make it suitable in the cold-lining process. It has a double function: it serves both in the treatment of a damaged paintfilm and/or canvas, and in the lining proper, though both actions are carried out separately.

Formerly we used to have in cold-lining two stretchers involved: the lining-canvas was stretched and the screen through which the lining-adhesive is administered to the lining-canvas was also stretched. Both were independent stretchers, the stretcher with the screen being smaller than the stretcher with the lining-canvas, so that the former fits into the latter. The painting proper was never stretched; it was simply placed on the lining-canvas on which adhesive had been applied through a screen. Now we also stretch (or pre-stretch, if one likes) the painting. So cold-lining now goes with a triple-stretcher method. In order to clearly distinguish between the three we shall henceforward indicate these stretchers as follows:

STRETCHER-A (stretcher with the painting on it);

STRETCHER-B (stretcher with a screen through which the lining adhesive is applied a. to get the painting stretched on STRETCHER-A,
b. to apply adhesive to the lining canvas);

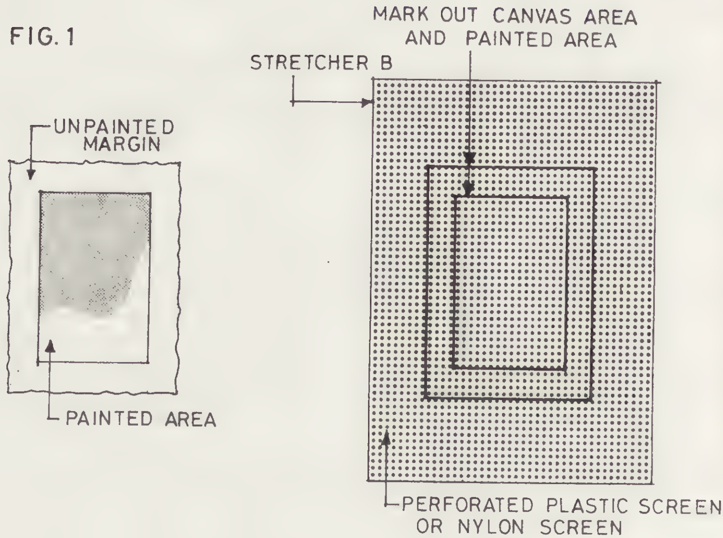
STRETCHER-C (stretcher with the lining canvas).

All three stretchers play a part in the lining process. STRETCHER-A is bigger than STRETCHER-B (so that B can fit into A), but is smaller than STRETCHER-C (so that A can fit into C).
Only STRETCHER-A and STRETCHER-B are involved in the final care given to a damaged paintfilm and/or distorted painting canvas, prior to lining. The procedure in taking final care of paintfilm and canvas is as follows:

Treatment of damaged paintfilm and canvas after pre-stretching.

On STRETCHER-A we stretch a non-woven, compressed nylon material. On STRETCHER-B we stretch a suitable screen, selected from a range of materials as noted in our ICOM-1975 report. The screen on STRETCHER-B should be at least 5 cm bigger than the size of the painting. On this screen we mark the exact size of the painting, both with and without the edges of the unpainted canvas (see Fig. 1). We then cover the screen with masking paper, leaving exposed only the area in between the two marked frames which, taken together, designate the unpainted edge of the painting-canvas (see Fig. 2).

FIG. 1


UNPAINTED MARGIN
PAINTED AREA
MARK OUT CANVAS AREA AND PAINTED AREA
STRETCHER B
PERFORATED PLASTIC SCREEN OR NYLON SCREEN

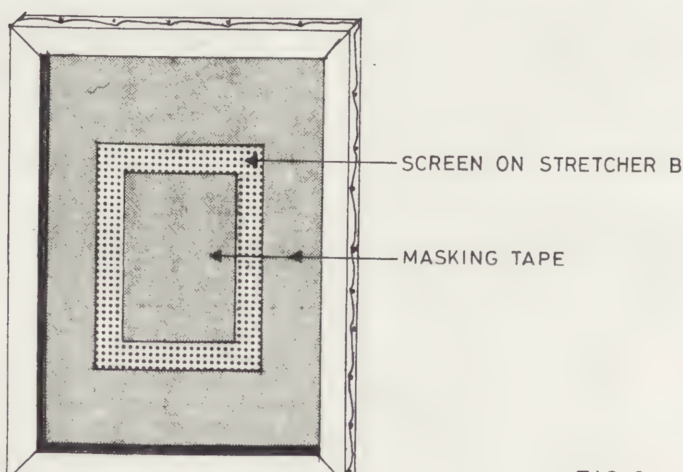
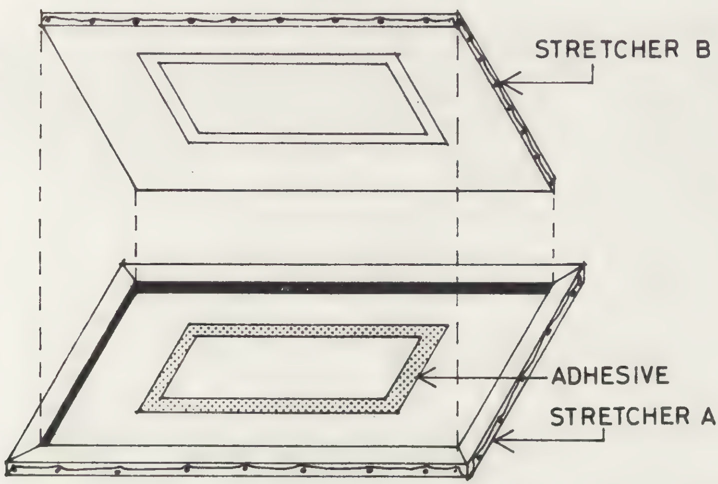

SCREEN ON STRETCHER B
MASKING TAPE

FIG. 2

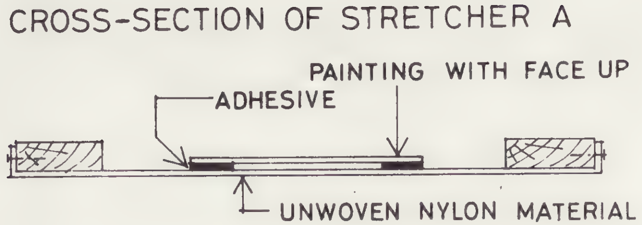
We now take STRETCHER-B and place it into STRETCHER-A on which we have previously stretched the unwoven nylon fabric (so STRETCHER-B should always be smaller than and thus fit into STRETCHER-A with the nylon fabric). We then take some adhesive (Plextol B-500, to which added 1% hydroxyethyl cellulose, Natrosol HHR-250, together stirred into a butterish paste) and spread it onto the exposed area of the otherwise paper-masked screen. The spreading is done with a rubber spatula; excessive adhesive is removed. After this we remove STRETCHER-B (the screen is washed at once, so it can be used later in lining the entire painting) and we perceive on the nylon fabric stretched on STRETCHER-A an adhesive-covered frame with dimensions equal to those of the unpainted edge of the painting-canvas (see Fig. 3).

Fig. 3



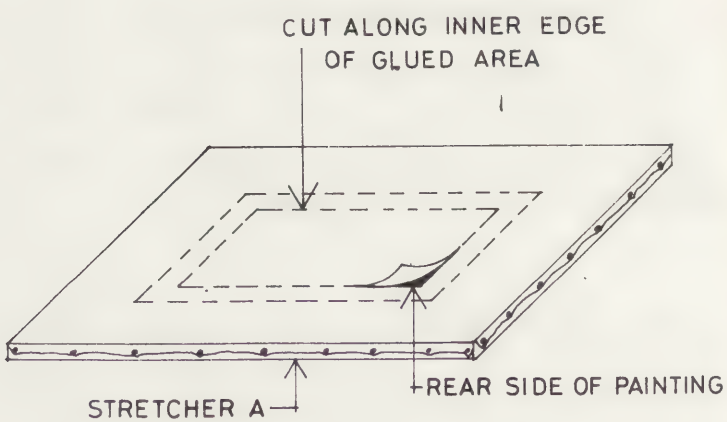
We now take the painting and place it (face up) on the stretched nylon fabric on STRETCHER-A; we see to it that the edges of the painting-canvas will coincide exactly with the adhesive-covered, frame-like area on the nylon fabric. Then we place STRETCHER-A (with the painting on top of the nylon fabric) on the low-pressure cold-lining table, we cover the entire table-top (and thus also STRETCHER-A) with a sheet of Melinex, we switch on the motor of the table and wait for cohesion to take place between the edges of the painting-canvas and the nylon fabric. Drying time takes approximately 30 minutes. After drying, the painting is attached to the nylon fabric only by its edges (see cross-section in Fig. 4).

Fig. 4



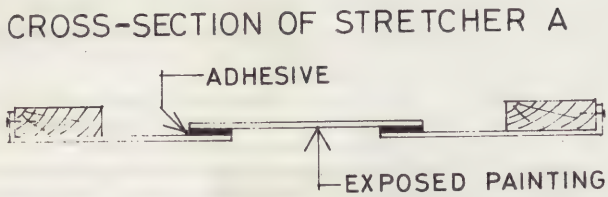
We now turn STRETCHER-A upside-down. Through the nylon fabric we can see precisely where the edges of the painting-canvas are glued onto the nylon fabric. We then cut out the area of un-glued nylon fabric (either with a scalpel or with scissors); this is the area which coincides with the painting's dimensions, not included the edges (see Fig. 5).

Fig. 5



When that area of nylon fabric has been removed the painting will be held stretched only by way of its edges which are attached to the remaining margins of the nylon fabric stretched on STRETCHER-A see Fig. 6).

Fig. 6



Atthis stage we are very close to starting final treatment of distortions in the paintlayer and the painting-canvas. Special notice should be taken here of the fact that henceforward the painting (paintfilm and canvas)remains fully exposed, so that the result of treatment can be observed directly at all times. All other methods of pre-stretching practised and known so far do not allow for direct observation of results of treatment of the paintlayer.In those methods the paintlayer is covered entirely with the material which plays a part in the pre-stretching.

We remove STRETCHER-A (now with the painting attached by its edges to the nylon fabric) from the table. We take a piece of linen fabric (or any other material which will easily absorb moisture), cut it to a size equal to the size of the painting (not included the edges), we moisten that piece of fabric with a mixture of water and di-acetone (1:1), we place the moistened piece of fabric on the low-pressure cold-lining table and put STRETCHER-A on top of it, while making sure that the surface area of the moistened fabric and that of the rear of the painting (painting face up) coincide precisely. We then cover STRETCHER-A with a sheet of Melinex and wait for approximately 15 minutes, in order to give the painting-canvas and the paintfilm time and opportunity to absorb some vapour from the moistened fabric underneath. The motor of the low-pressure cold--lining table is not switched on during these 15 minutes; the painting--canvas rests on top of the moistened fabric and it will absorb some vapour from the fabric moistened with water and di-acetone; the water-vapour serves to relax the painting-canvas, the di-acetone (or any other suitable solvent) gives the paintfilm a chance to relax as well.

After about 15 minutes we remove the Melinex sheet from the top and the moist fabric from under the painting and we check the painting's condition. We shall see that the painting-canvas has markedly relaxed, i.e. that is has become slightly flabby. We then place STRETCHER-A with the painting back on the table, carefully key out the stretcher in all four corners, so that the canvas, under slightly increased

stress,gets straightened out again we then replace the Melinex sheet on top and switch on the motor of the table; (so this time the moistened fabric is not there). While the table is in operation, exerting low pressure on the painting, the painting-canvas will further straighten out and the distortions in the paintfilm, such as cupping, will diminish considerably. At the same time the vapour absorbed into the paintfilm and the canvas will be withdrawn through the perforations in the table-top. It will be drawn down and away from the painting and sucked out through the tube under the table (see for details our ICOM-report 1975).
After about 20 minutes we switch off the motor, remove the Melinex again, and again check the painting's condition. If improvement of the painting's conditon is found to be insufficient yet, i.e. when the distortions are still too strongly visible, we may repeat the process two, three, four or more times, until we are fully satisfied with the result; that is: until we feel, that, within the limits of a gentle and safe procedure, the utmost has been done to bring the painting,as much as possible, back to what it should be, what it was like in origin.
It is difficult to be precise here. An experienced restorer knows, though, what he or she can do in terms of improving a painting's physical condition, just as he or she knows when to stop trying further; in other words: when a restorer's intervention may lead to further damage instead of improvement of the object under his or her care.

When we feel satisfied with the result of the treatment as described, we shall proceed with stabilisation of the painting as a whole. This is done by impregnating the paintfilm, ground and canvas alike, with a 5% to 10% solution of Plexisol P-550 (polybutyl methacrylate, Röhm & Haas)in white spirit; the white spirit used should have a 17% aromatic content in order to make the polybutyl methacrylate dissolve properly. The solution is spread on both sides of the painting with a soft brush. The painting remains stretched on STRETCHER-A. After impregnation we do not touch the painting for about a day. We leave it on the stretcher and let it settle. The stretcher is kept in a vertical position and free, so that the solvent in the consolidant can evaporate. When evaporation is complete we are ready for lining.

Preparing a painting for lining after consolidation

Whereas nothing further is to be done with STRETCHER-A and STRETCHER-B, we proceed with stretching a suitable lining canvas on STRETCHER-C (woven polypropylene, polyamide or polyester fabric; see for specifications our ICOM-report 1975).
STRETCHER-C should be at least 10 cm bigger than STRETCHER-A, so that STRETCHER-A can fit into STRETCHER-C. We are now prepared to start the actual lining. But let us once more review shortly what is involved in terms of the materials and structures needed in this triple-stretcher system. We shall have ready:

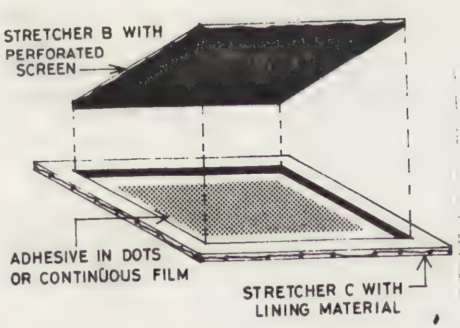
1. STRETCHER-A on which the painting is stretched (only attached by its edges) with the help of a non-woven, compressed nylon fabric. Care of paintfilm and painting-canvas has been completed.

2. STRETCHER-B on which the selected screen has been stretched, the same screen as the one we used for sealing the edge of the painting-canvas to the non-woven nylon stretched on STRETCHER-A. After sealing the edges of the painting, the masking paper has been removed from the screen and the screen has been properly washed, so it can be used again in the application of the lining-adhesive on the lining-canvas stretched on STRETCHER-C.
3. STRETCHER-C on which the lining canvas is stretched.
4. A pot with Plextol B-500 to which added 1% Natrosol HHR-250 (hydroxyethyl cellulose), together stirred into a butterish paste. The hydroxyethyl cellulose is a thickener which can immobilise the water molecules in the water-based adhesive through hydrogen bridges. Other cellulose derivatives which can be used are carboxymethyl cellulose and methyl cellulose (see also our ICOM--report 1975).
5. A rubber spatula with which to spread the emulsion on the screen when STRETCHER-B has been fitted into STRETCHER-C with lining canvas.
6. A sheet of Melinex (polyester foil), big enough to cover the entire table top of the low-pressure cold-lining table during the actual lining process.
7. A sheet of polyurethane foam big enough to accommodate the table--top area of the cold-lining table. We place this material between the perforated table-top and STRETCHER-C (with the lining material) in which STRETCHER-A (with the pre-stretched painting to be lined).

The lining process

STRETCHER-C with the lining material is placed on the low-pressure cold-lining table. STRETCHER-B with the screen is placed into STRETCHER-C (it follows that STRETCHER-B is smaller than STRETCHER-C). Then the prepared Plextol emulsion is carefully spread out over the entire screen (which is slightly bigger than the painting stretched on STRETCHER-A). For this we use the rubber spatula. Excess adhesive is removed. After that we take STRETCHER-B out of STRETCHER-C. We then see that the lining material on STRETCHER-C is covered with the Plextol emulsion which passed through the screen (see Fig. 7).

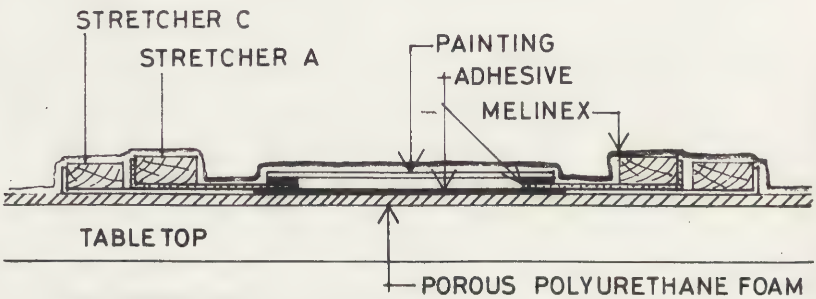
Fig. 7



It will be either a dotted pattern or a thin, homogeneous, closed film of adhesive, depending on the kind of screen we have selected. A not too densely perforated screen will leave on the lining-canvas a dotted emulsion pattern, whereas a very densely perforated screen will leave a closed emulsion film. In absence of the kind of perforated screens which we had manufactured particularly for the purpose of lining, one may just as well use easily available curtain-net (vitrage fabric). Such fabric is usually finely woven and will, when used in the lining process, produce a thin, homogeneous emulsion film.

After removal of STRETCHER-B with the screen we take STRETCHER-A with the pre-stretched painting and place it (painting face up) into STRETCHER-C with the lining-canvas, which is now covered with the lining-adhesive; it has been mentioned before that also STRETCHER-A must fit into STRETCHER-C.
When placing STRETCHER-A into STRETCHER-C we must see to it that the painting-canvas will properly touch on the emulsion-covered area of the lining-canvas on STRETCHER-C, i.e. that no part of the painting-canvas is left free of adhesive.
Finally we take the Melinex sheet, we cover stretchers and table--top with that Melinex, and switch on the motor of the low-pressure table (see Fig. 8).

Fig. 8

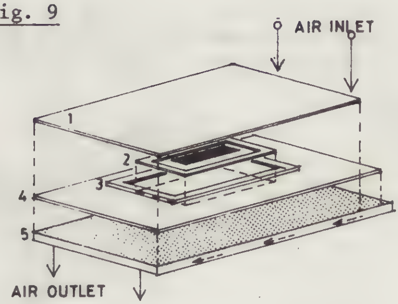


CROSS-SECTION OF LINING PROCESS
ON THE LOW PRESSURE TABLE

At one side the perforated table-top is left uncovered over a width of approximately 5cm, for air-intake and resulting air-circulation under the table-top (see Fig. 9).

The actual lining has now begun and will take about 30 minutes to get ready. Within that period the emulsion will have dried and under gentle pressure, obtained through suction of air through the perforated table-top, the painting-canvas and lining-canvas will have properly joined.

Fig. 9



1 MELINEX
2 STRETCHER A
3 STRETCHER C
4 POROUS POLYURETHANE FOAM
5 TABLETOP

Restretching after lining

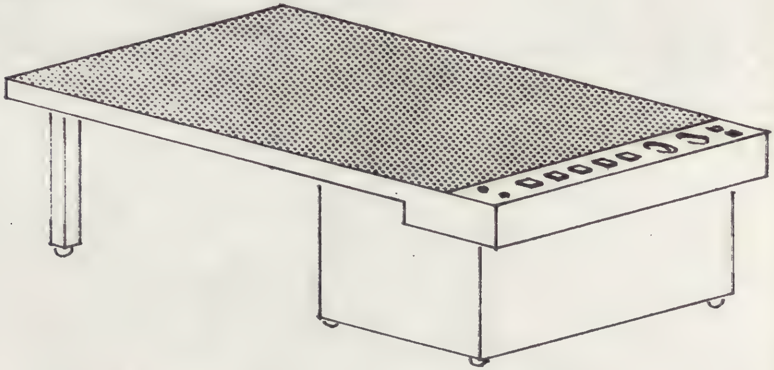
We could at this stage proceed with removal of the marginal nylon fabric which still holds the painting stretched onto STRETCHER-A, but usually we prefer to wait for a day or so to let the joined canvases get settled. Only then we remove the now superfluous nylon fabric, cut away the superfluous lining-canvas along the edges of the painting and restretch the now lined painting back onto its frame. (We may note here that the non-woven nylon, used in stretching the painting on STRETCHER-A, is entirely removed, apart from the edges and the lining-canvas covering those edges, and as such provides the painting's edges with additional strength.)

The low-pressure cold-lining table

Technical features of the table have been extensively described in our reports for Greenwich-1974 and ICOM-Venice 1975. We shall not repeat the details, but it may be useful to give a short review of its function, in as much as that function diverts from that of the hot-table:
The design of the table has been entirely inspired, or dictated rather, by the requirements for lining specified in our earlier papers. During the lining operation on this table, the painting is subjected to a very low and homogeneous pressure, which is just enough to effectuate good adhesion between the painting-canvas and the lining-canvas. At the same time the use of this table allows for quick and easy evaporation of moisture in the lining adhesive. The table-top is flat and rigid and perforated. When painting and lining-canvas are placed on this table-top, the moisture in the adhesive will be drawn away downward, away from the painting. Evaporation is speeded by constant air-circulation in the area right under the perforated table-top, while at the same time gentle pressure is exerted on the painting's surface. Gentle pressure, no vacuum as on the hot table. Moreover, pressure through air-suction

is on the low-pressure table homogeneous from the start, due to the fact that the table-top is perforated with thousands of tiny holes. On the hot table air is sucked out through holes in the four corners

Fig. 10



LOW PRESSURE TABLE TYPE 2

of the table-top; thus, when put in operation, pressure will start to build up along the sides of the table-top first, and then gradually spread to the middle where the painting is situated. The vacuum which is finally created between a painting and the Melinex with which it is also covered in lining on the hot table, causes unnecessary and unwanted stresses on the painting's surface.

ad 5. Can we cold-line without a low-pressure cold-lining table?

Yes we can. Until 1974 we did not have a cold-lining table ourselves and we managed to do cold-linings with satisfactory result. What we lack in the absence of a table is:
a. low and homogeneous pressure on the entire painting and

b. air-circulation under the painting during lining.
Before we had our table, we used to cold-line simply on a flat surface. Pressure needed to obtain good cohesion between painting-canvas and lining-canvas was acquired by spreading a homogeneous layer of sand over the Melinex sheet which covers the canvases to be joined. Due to a lack of air-circulation, drying of the adhesive between painting canvas and lining canvas could take up to one to two days, ad compared to the mere half hour which it will take when the low--pressure table is employed.
As to obtaining some air-circulation, there is, however, room for improvisation. One may construct, on on's own, a device consisting of two rectangular pieces of a rigid material (a metal or a strong board) which are separated and held together at the same time by an inner structure of a kind which will allow air to circulate freely. The piece of rigid material on top is perforated, the bottom

piece is not. We seal this structure (which is basically identical to the structure of our table-top) on three sides. The remaining side is left open. Through that open side we insert the nozzle of a vacuum-cleaner. Either by having the vacuum cleaner blow in air or suck it out, we create air-circulation under the perforated top of the structure, which will serve as a table-top for lining.
It must be noted, though, that with this improvised method in order to obtain air-circulation under the painting which is lined, we do not get any pressure on top of the painting's surface. That pressure, needed to obtain sufficient cohesion between painting-canvas and lining-canvas, can be created through employing sandbags or loose sand on top of the Melinex with which we cover the two canvases to be joined.

ad 6. Can we use in cold-lining different materials?

The lining canvases and lining adhesive and consolidant which we use were selected after testing a wide range of different materials. Those selected were the ones which stood up to all requirements which we listed when we set out to find a lining method which will bypass the acknowledged drawbacks in conventional lining practices. Specifications concerning the materials selected are given in our ICOM-report 1975. There it also says where those materials can be obtained. We would therefore advise our colleagues who do want to put cold-lining to the test, to employ the materials we use as well.

Postscriptum

We recall that we have made a film on the cold-lining process. This film was shown at the ICOM-conference held in Venice 1975. It can be seen at our laboratory, or it can be obtained on loan from us. With the present paper we believe to have said all we can say on the work which has been done so far. We are now ready to concentrate on a different aspect of painting restoration: a study of the behaviour of stretchers on which paintings are kept for display and for storage and a study of stresses exerted on a painting during stretching.

In this paper we have not dealt with all aspects of cold-lining. What was left out can be found in our previous papers, notably the most recent one which we did for the ICOM-conference held in Venice three years ago. We ended that paper with an almost personal appeal to our colleagues who are just as worried about the disadvantages of conventional lining practices as we are. Since this may be the last paper on the subject for some time to come, we would like to conclude it in the same spirit:
In the method and materials discussed here and in our previous papers, there are various aspects which in our view, deserve particular attention: the elimination of heat, a considerably reduced increase in weight of a painting after its lining and the fact that the adhesive used in this lining process can be employed in different degrees of cohesive strength. Also an important feature is that reversibility is easy due to the circumstance that the relatively low amount of adhesive needed is applied only onto the

lining-canvas and merely forms a nap-bond pattern or a thin, perfectly homogeneous film between the painting's canvas and the lining--canvas. Also with regard to the lining of modern paintings (i.e. thin paintfilms, matt presentation, heavy impasto, paintfilms, ground and/or canvas left exposed partly by the artist on intention, and the like) the cold-lining method and the use of the materials employed allow for a safer conduct in the lining process and the restoration of damages in the paintfilm. A process which should become ever more gentle.

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ABSTRACT

This contribution to the Working group on Stretchers and Lining of the ICOM-conference 1978 is a review of studies undertaken at the Central Research Laboratory for Objects of Art and Science in Amsterdam. The studies were aimed at finding an alternative technique to standard practices in the lining of canvas paintings, in answer to a growing awareness among restorers in this field that the starch-glue and wax-resin lining techiques have shown to be insufficiently compatible with the properties of painting materials. The alternative technique discussed is a cold-lining method involving a triple-stretcher system, the latter being the result of studies and experiments undertaken in the three years which passed since the ICOM-conference held in Venice, 1975. Apart from a review of the lining technique concerned, attention is given to questions put to the author by colleagues. An attempt is made to answer those questions satisfactorily.

RESTAURATION OF PANORAMA-PICTURES (CYCLORAMAS) WITH THE APPLICATION OF LIGHT-WEIGHT SUPPORTS (PROBLEMS AT THE RESTAURATION OF THE 'FESZTY-CYCLORAMA-THE HUNGARIAN CONQUEST')

Ervin Kisterenyei and Árpád Szücs

Summary. On the thousandth anniversary of the Hungarian conquest of present-day Hungary which took place in 896, the painter Árpád FESZTY painted a vast cyclorama with his fellow painters whoch was set up in Budapest. The work was seriously inujred during the Second World War. In 1975 Ervin KISTERENYEI was entrusted with its restoration who, with his team of young restorers has been continuously doing this work since 1976. Having studied similar cases he discarded traditional methods. Experimentally he worked out a new technology, unusual for restoring a canvas. He glues the picture in pieces measuring 15 by 4 metres on arched panels of light structure which, in turn are hanged side by side in the form of a circle. This solution eliminates the greatest problem that of the sag /convexity/. Experimental results have borne out the rightness of this ides up to now.

Thy cyclorama entitled "The Hungarian Conquest" painted by Árpád FESZTY /1856-1914/ and his companoins László MEDNYÁNSZKY /1852-1919/, Béla SPÁNYI /1852-1914/, Ignác UJVÁRY /1860-1927/, Celesztin PÁLLYA /1864-1948/, all well-known painters of their days, between 1891 and 1894, was on show first in Budapest from 1894 to 1900. To the 15 m high picture of 120 m perimeter and 1800 m^2 surface, a three-dimension foreground a so-called diorama, too belonged.

On the occasion of the world exhibition in 1900 the cyclorama was transported to London and was brought back to Budapest in 1912 only. In the meantime the building that originally housed had been pulled down, so the work was set up in a new building of wooden construction. Operations were directed by Árpád FESZTY himself. He also made corrections in the picture. It was then that and 80 cm wide strip was joined to the cyclorama.

Round 1930 the picture was restored, renewed, that is it was cleaned and the figural parts varnished.

The building standing in the big park of the capital called Városliget, was hit by a bomb in the autumn of 1944. Approximately 20 per cent of the picture was seriously injured and destroyed respectively. The minor figural parts dug out from beneath the ruins in 1945 were "restored" and got scattered to various places. The larger, remaining parts of the cyclorama were disjoined in 1947. After several temporary places of storage this wreck of a picture of about 14o0 m^2 was carried into the store-

room of the Hungarian National Gallery where, at the end of the 1960s, a 40 m^2 /5x8 m/ piece of it was restored and stretched on a wooden frame, put on view in Budapest and Szeged.

The topic of the cyclorama is the 896 Hungarian conquest of Hungary. It was decided that in the scene of the first Hungarian diet following the conquest of the country, Pusztaszer - as had by tradition and confirmed by the results of archaeological excavations - a National Memorial Park will be formed. The village Pusztaszer lies north of Szeged not far from the river Tisza. This is the place where the cyclorama will again be displayed under the auspices of the Szeged "Móra Ferenc" Museum to whose care it was committed in 1975.

Works, similar in character to Feszty's cyclorama, can be found in several countries of the world. Everywhere the decision was against letting them perish and for assigning them their proper place.

The picture, torn, cut or undone to more than 60 pieces of various sizes, now stored on large wooden rolls, was painted on Brussels canvas. The 8 m wide pieces stitched together have considerably weakened, in several places the threads are friable. The priming and the upper layer of paint are crackled, here and there 20/50 per cent have peeled off. A 16 m long part, with the exception of a few figural fractions, has completely been reduced to nothing. When taken away from the ruined building the canvas was cut into two a little above the skyline. The figural parts of an average height of 6/8 metres, were separately stored. The sriously damaged pieces of the "firmament" cannot be included on account of their condition.

The restoration of the cyclorama to be done in more than one step and in the course of several years, is being performed by a team of young restorers, graduated only a few years ago from the Academy of Fine Arts, under the author's leadership.

In the summer of 1975, in two months, we sized up and documented the material. We have been working continuously since June, 1976. We have taken the canvas, originally sewn together of 8 m wide strips, apart along the seams. The smoothing and ironing of a deformed canvas of such sizes can hardly be controlled. Practice has proven that much narrower pieces, too, presnted difficulties. So halving these sheets we have arrived at the 15 by 4 m measurement. From this time on these sizes were our basis to start from. By the end of 1977 we conserved the pieces of picture, filled up the discontinuities; we prepared them for relining.

Knowing about the difficulties faced and experiences gained when restroing similar cycloramas in Gettysburg,

Moscow and Salzburg, right from the beginning we have been looking for a new solution of fastening to light structures.

The Gettysburg cyclorama was in an almost similar condition and after a "restoration" performed in an unprofessional way without due circumspection when it was renovated in the early 60s. 1/ /National Military Park, Pennsylvania, USA/.

One of the greatest problems is with the rejoining of a picture uf such sizes and structure. W.J. Nitkiewicz wrote in a letter written to us the following: "My theory is that when a full size cyclorama painting is cut while hanging in convex form, it cannot be rejoined as a free hanging canvas because the cut edges become bowed and cannot be butted together. It may be possible to butt join them together if they can be attached on rigid panels that are formed precisely as the shape of the painting before it was cut."

Germain Bapst discusses a problem closely connected to ours in his work entitled "Essai sur l'histoire des panoramas and dioramas/. "In the panoramas the upper edge of the canvas is fastened to a strong circular wooden frame, /see A in Fig. 1/ and its bottom to an iron ring on which weights are hung to ensure continuous stretching. In spite of this stretch the canvas will bulge somewhere in the middle and the diametre of the iron ring must be smaller than that of the upper frame so that it will pull the canvas a little forward. This way the shadow resulting from the verticality of light can be eliminated. This convexity characteristic of cycloramas may be as much as a metre in case of a 15 m high picture."

The result of this phenomenon we, too, could experience on the occasion of sizing up the Feszty cyclorama. When spreading flush the pieces to be rejoined their edges were arched. The presence of this phenomenon indicated that the canvas had been affected not only by a vertical but also by a horizontal stretch. When such a picture has to be taken into pieces for smoothing, the edges of the parts, when hung to be butted together are no longer straight, along the seams and cuts they deviate.

The problems stemming from convexity made difficult to rejoin the parts of the Gettysburg cyclorama, too. ... "When we butt joined together the pieces now hanging plumb /see B in Fig. 1/ big waves formed in the lower part of the picture on both sides of the butts. The neighbouring parts which were not bowed, did not show this unevenness, after rejoining. These unevennesses were, therefore of a local character not eliminatable by stretching along the perimeter. With some stretching and proper lighting however, this effect could be elim-

inated to some extent" writes Nitkiewicz. Although the Gettysburg cyclorama was reduced to half of its original height, convexity caused problems when it was set up again. As a result of the method employed for rejoining its parts, this is less visible from a certain distance /from the auditorium/, but "in spite of all the manipulating, some distortions are visible".

The distortion of the canvas is caused by the permanent deflecting force, the simultaneous vertical and horizontal stretches. If, after relining, the picture getting considerably heavier thereby, is once more hung, new problems will present themselves before long.

In 13 years after restoration the grounding /putty/ and the paint chipped off along the butts of the Gettysburg cyclorama, the original canvas and the one used for relining came unstuck in several places. W.J. Nitkiewicz attributed all this to the fluctuation of relative humidity between 20 and 90 per cent.

We made more than one plan of how to set up and make the cyclorama borne by light structure. First we wanted to fasten the relined canvas to wooden frames. This solution would have entailed the decrease of the picture's height to 10 m and omission of the diorama /see the Gettysburg cyclorama/. We could have done it all the more as the highest piece is not more than 8.50 m at present. When making the plans for the frames of special construction to be made of laminated wood we had to relize that 30 such frames fastened together would not be suitable for the purpose for their unpreventable "move", warping.

Mounting on metal support /aluminium closed shape/ was also broached. In this case, we should have taken into consideration, besides weight problems, the sizeable thermal expansion.

The polygonal form, instead of the circle, we found unacceptable for aesthetic reasons.

After these we experimented with impregnated honeycomb cell structures filled with polyurethane hard-roam. To make the "foam carped" of 70 mm thickness firm, we designed a system of bracings, similar to the construction of the wing of a glider. In this case we would have formed the curved surface by placing many small flat ones one after the other.

Although we worked with a light material, the bracing, which was to ensure stability, greatly increased the load weight which, thus was not much less than the weight of the wooden frame would have been. The butting of comparatively small building units presented grave technological problems.

Polyester resin reinforced with fibreglass combined with various cores /carton honey-comb cell, aluminium honey-comb cell, balsa/ is being applied in several fields today apart from the boat-duilder artisan who has elaborated its technology. For restoration purposes it is used in the Central Institute for Restoration, Rome, where epoxy resin textile glass plus carton honey-comb cell /aluminium cased sandwich panel/ is applied as new support for murals removed from their original wall.

We, utilizing the technological experiences of the Balatonfüred shipyard, have formed the arched pieces of aluminium cased sandwich panels based on impregnated, stretched carton honey-comb cells 4/ closed on both sides by glass quilt plus polyester resin 3/ laminate /Fig. 2/.

We prepared testing samples of various largenesses and thicknesses of carton honey-comb cells of 35 mm diametres. These were impregnated with polyester resin diluted with styrene or with Paraloid B.72 solved in acetone, nitro-thinner /10-15 per cent/. For laminating the testing specimens we used glass quilts of 225 gs/m^2. With the combination of glass quilts and textile glass, with the increase of the number of layers, almost any grade of stability can be achieved. We measured 7/9 kp/cm^2 separation and tensile strengths when testing our specimens of 8x8 cm largeness and 1.5 cm thickness. In case of a well prepared aluminium cased sandwich panel it was always the core material that broke.

When the laboratory experiments finished in 1977, the final technological plan for setting up the cyclorama took shape. This must be taken into consideration by the designers of the building, too.

Together with the parts to be painted anew the surface of the picture will be 1800 m^2 again. It will be borne by 30 panels of 15 by 4 metres. A panel comprises 150/200x 400 cm arched prefabricated elements. The elements can be turned out of the above materials by simple handicraft technology in series.

On the concave side of the panel a 3 mm thick PVC hard-foam layer /AIREX/ 6/ is stuck by epoxy resin /Araldit/ 5/. This will connect the relined picture and the panel.

In this case the PVC foam is a /a/ a transitional layer - in case of any problem the picture can easily be removed from the panel; and /b/, on account of its texture the foam is also a compensation layer between the picture /canvas/ and the bearing structure. 7/

The panel is 15618 mm thick /Fig. 3/. 100 cm far from each edge runs along its back the hollow bracing rib /a/ to the upper part of which is joined a specially formed clamp on both sides /b/ enabling the mounting of

the panel on the wire rope /d/ that stretches between the original bearing bar /c/ and the floor. On both sides of the ribs 3 further distance pieces /e/ fix the picture. The pieces following each other are joined at their back with the aid of L-holders /f/.

The forming of the panel and the mounting of the relined picture on it is performed in one working process on a tiltable and movable arched form /platform/.

The ready segments are carried to their final place on this form, adjusted to vertical position by tilting it, then fixed to the wire rope stretching vertically between the mounting bases.

In 1978 we are to make the first bigger testing specimens and, at the same time start relining of the parts of the picture. 6/ By 1980 the final, air-conditioned building of light construction will be ready at Pusztaszer. According to out estimations two years will be necessary for the assembling and setting up the panels on the spot. The pieces already standing are being given the necessary completion /reconstruction, retouching/. We expect that at the time of the final touches the cyclorama will already be accessible by visitors.

Inauguration is planned to be h eld in 1983.

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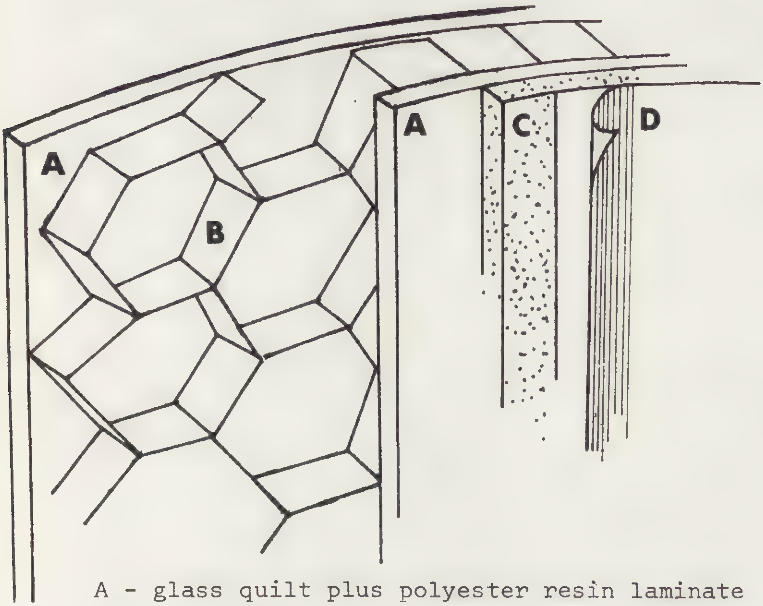
5. ARALDIT AW 106, HV 953 U. CIBA - GEIGY. Basel, Switzerland.

6. AIREX -k, PVC hard-foam. "Spezialschaumstoffe". AIREX - AG. CH - 5643 SINS. Switzerland.

7. Brambilla Barcilon: Techniche de Restauro degli affreschi. /PVC hard-foam in the technics of restoration/ Materie Plastiche ed Elastomeri N. 12. - 1968.

8. We have the canvas manufactured in France.



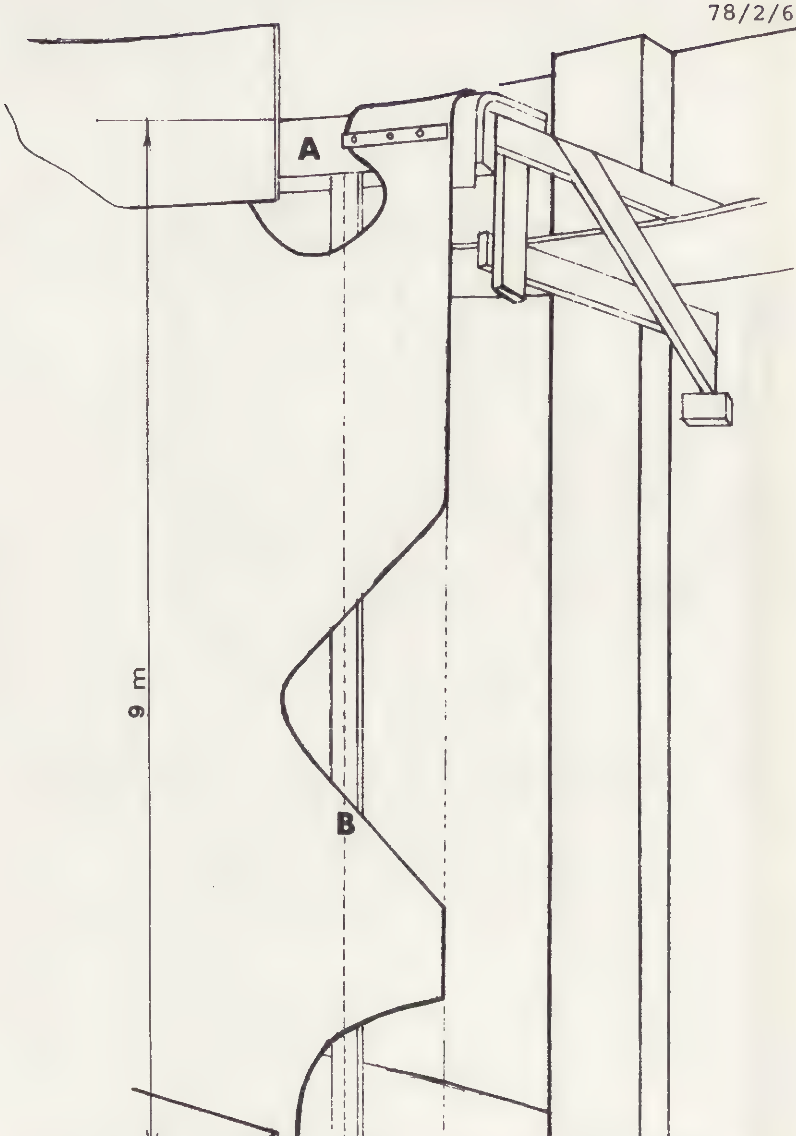
A - glass quilt plus polyester resin laminate

B - impregnated carton honeycomb-cell

C - PVC hard-foam /AIREX/

D - original and relining canvas

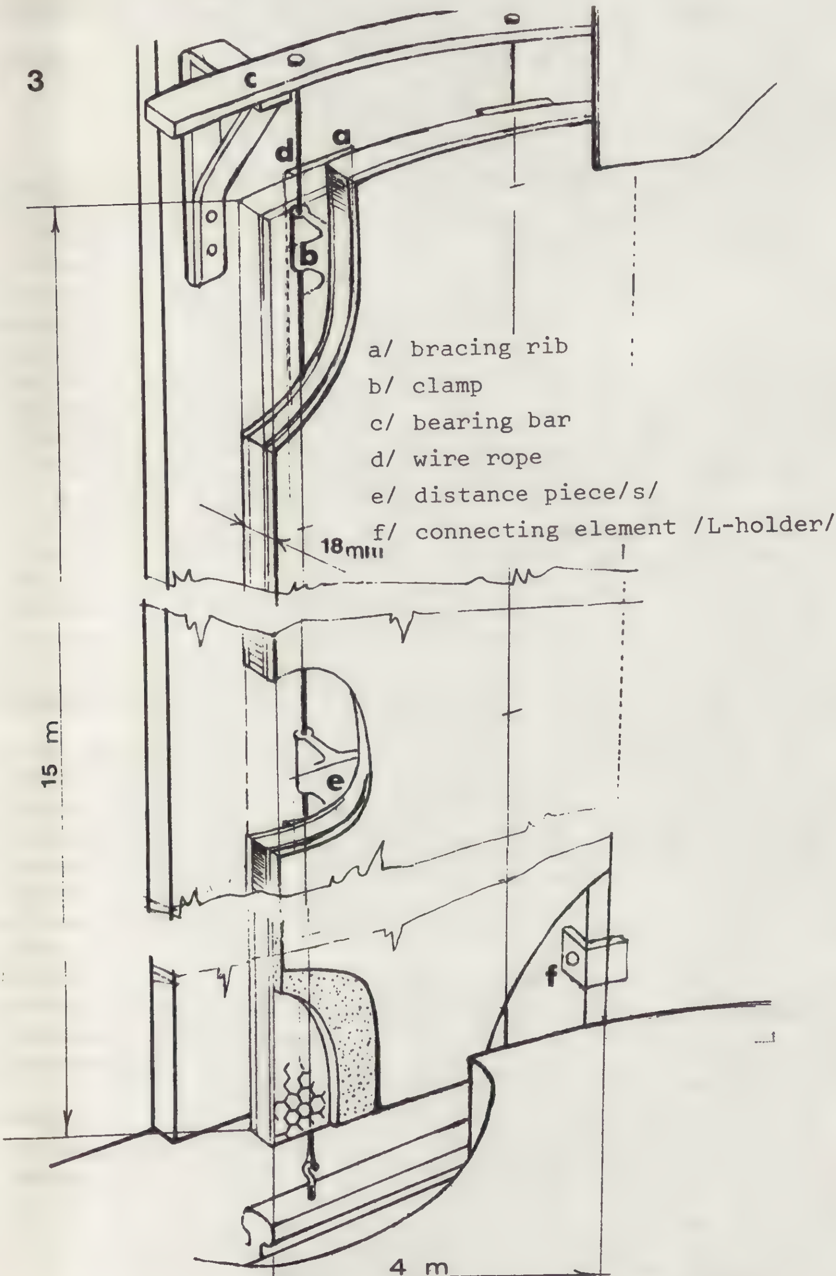
78/2/6/8



1.

Erection drawing of the Gettysburg cyclorama
(According to C.A. Morgenthaler)

Erection drawing of the light structure to bear the Feszty cyclorama



ELECTROSTATIC HOLD: A NEW TECHNIQUE OF LINING

Robert E. Fieux

Abstract:

An integrated lining system to supplement existing methods, developed specifically to avoid the injurious combination of surface pressure combined with heat and penetrating adhesives. The concept is based on a contact silicone adhesive requiring no heat or pressure and which does not enter the structure of the painting. Cupping and other deformations of the painting are flattened by use of specially designed mechanical strainers that apply lateral tension upon the edges of the painting, instead of surface pressure. Paintings that have structural degeneration requiring penetrating adhesives are treated on a newly designed Electroplaque Hot Table that holds the components of painting and lining down flat by electrostatic attraction, avoiding application of surface pressure.

General Description:

Many paintings require lining for reasons of additional structural support to the canvas only, which involves simple adhesion to another fabric but not necessarily penetration of an adhesive throughout the entire structure of the paintings. Other paintings are exceptionally sensitive to heat or to the combination of heat and pressure, or the repeated heating cycles of current lining methods; these may be traditional in style executed in a softer medium, while among contemporary works there are many paintings which are extremely vulnerable to standard restoration procedures.

When a strong, stable fabric is prepared with the silicone contact adhesive and the painting applied enough structural support is provided to assure that a slight accidental occurrence will not easily damage the

painting, or that the old canvas may fail spontaneously under the stress of stretcher tension. Fiberglass, which is dimensionally unstable and easily broken with a few sharp folds, can be greatly strengthened upon unification of its weave into an isotropic structure by an adhesive layer, especially if a backing canvas is added with the same adhesive, and it has been found ideally suited as a substrate for the silicone adhesive for use as a lining for easel paintings. This style of lining is completely satisfactory for those paintings having no other need than to be placed upon a secure new support.

Other paintings, also not actually in need of impregnation for internal structural problems, may have deformations of the paint plane in the form of cupping, buckling, wrinkling or other commonly encountered irregularities that are unsightly in appearance but may in no way affect the internal structure. Usually such deformations cannot be properly treated by addition of a support without preliminary attention. Such paintings are first flattened through application of lateral tension by means of specially designed mechanical strainers, after which the painting is then lined while still mounted in the strainer.

Paintings that have internal structural degeneration, decayed and fraying canvas, flaking or delaminating paint layers, or a general break-down of internal cohesion in the paint-ground-sizing layers that can only be corrected by penetration of an adhesive of the heat activated type are treated on the Electroplaque Hot Table, in conjunction with the strainer if necessary. The general requirement that the painting be maintained in a flat attitude, and if being lined also be kept in uniform contact with the lining during the process is met by electrostatic attraction of the work down against the table top rather than by pressure on the painting surface. Alternately, a method has been devised making possible electrostatic hold with ordinary vacuum hot table equipment; but this technique is not as versatile as the Electroplaque Hot Table, since the strainers cannot be used simultaneously. Also, the Electroplaque

Hot Table has been found to have interesting potential in the treatment of paper articles and textiles as well as paintings.

The Adhesive:

The dry, cold, pressure-free silicone contact adhesive forms the fundamental basis for the system making possible the lining of paintings while completely avoiding thermal or mechanical stress on the picture. Any painting can be lined by this method whether it is totally free of all structural flaws, only needing to be "backed"; or, a painting can be flattened, or impregnated with another adhesive first, including wax and then lined in this way afterward. It is not an impregnating adhesive, but rather serves the primary function of any adhesive, to hold two parts together.

The adhesive is unique in many ways, especially for conservation purposes. As a silicone it is one of the most stable of synthetic compounds, and in this particular instance has been fully cured and cross-linked prior to use so that it will not undergo any further chemical change; and remains reversible indefinitely upon application of benzine (white spirit or naptha) leaving no residue on the picture. It is colorless, and is not subject to discoloration upon aging. It is very stable under intense ultra-violet radiation and is used to affix solar cells in satelites. It is non-flamable, non-toxic and odor free.

Bond strength specifications are well in excess of those required of a lining adhesive. Tested shear strength of a canvas to fiberglass lamination 24 hours after joining was 25 pounds on a 2 x 8 inch strip; (11 kg on a 5 x 20 cm strip). The weight of a heavy canvas fragment with a thick paint film was weighed at only .1 oz, (3 gm) in the same size, which is the actual load the adhesive would have to bear. Tested for one year at ten times this stress for cold creep (static shear) showed no sign of strain. The adhesive film is slightly flexible, reducing the potential for build-up of internal lining stresses.

To line a painting on a previously prepared lining it is only necessary to place the painting on the exposed adhesive and brush, pat or smooth with the palms of the hands, or roll lightly with a soft rubber roller, cold. The painting should be prepared by smoothing the back, cleaned, and all other preliminary treatments completed prior to lining.

The Mechanical Strainers:

Almost all irregularities in the paint plane are due to linear movement of the components of the painting structure in the paint plane. Because there is a limitation imposed preventing any linear extension beyond the stretchers, many distortions and undulations in the surface of the painting are caused by buckling caused by this limitation which results in compression in the lateral plane. Curling of the paint, cupping, even bulges caused by pressure or blows on the canvas become linear extensions or shrinkage in the plane. This is true of distortions caused by uneven tensions imposed by stretchers, keying out, environmental factors and many other causes. In general all are linear distortions that can be corrected by application of properly applied tension in that plane. This would not be so if a painting were constructed, for example, like a mosiac of tiles. In such a case, perpendicular pressure on any tile that were out of plane would be the correct way to put it back, while pulling on the edges of such a construction would accomplish nothing. The reverse is true of paintings.

There is a relationship between lateral (or linear) movement and degree of deflection in a plane; in a 1000 mm length a shortening of 1 mm will result in about a 10 mm deflection. Conversely, one or more deflections all adding up to 10 mm can be flattened by a linear pull of only 1 mm. If this is tested with any piece of paper, pushed together only a millimeter or so, it will readily be seen that very small linear movement results in severe deformations in the plane. This forms the basis for the operation of the mechanical strainers.

In construction the strainer consists of a rigid aluminum frame having on each side a "floating" side attached by studs and a pair of inner and out nuts. Turning all the nuts on the studs of one side equally will move that expanding side outward parallel to the fixed side, or one end can be moved more than the other to compensate for more or less pull required at any point on the edge of the painting. The painting itself is fastened into the strainer by being attached to the floating sides using a fine gossamer fabric with the same silicone adhesive. All four sides can be so moved.

Flattening is accomplished, after the painting has been mounted, by gradually warming the painting to no more than 100°F (38°C) a slight spray of finely atomized water, that can be mixed with solvents, on the back, and careful application of tension on the sides of the painting when it has become flexible and pliant. Duration of treatment and degree of tension vary from painting to painting which is very quickly learned by experience. The hot table is the most convenient source of heat, but any controlled source of warmth will do. After flattening, the painting can be lined as above while still in the strainer, after which it is cut away.

<u>Electrostatic Hold</u>:

With the system providing other means of lining and flattening paintings, the last remaining element required is some means of keeping a painting uniformly flat when treating with a penetrating adhesive for internal degeneration of paint or support, the reason being that these adhesives are thermally activated, and when cooled produce a "set" shape to the painting; if irregular, that shape will be permanently set into the painting. It is this same action that is responsible for textural deformation becoming locked into permanent misshapes under vacuum pressure. Electrostatic hold is able to provide an efficient replacement for this need, while eliminating the possibility of textural alteration, and the necessary flat attitude is assured.

The Electroplaque Hot Table contains two separate functions, a controlled heating system, and a built-in static attraction capability, each of which can be operated independently. It can be used to merely warm or heat work and held at a desired temperature, it can be activated to attract and hold down a variety of materials other than paintings, including paper and textiles, or both functions can be combined to activate an impregnating adhesive while a lining or consolidating operation is carried out. The top is unencumbered with accessory apparatus so that a painting in a mechanical strainer can be impregnated, or otherwise treated in a convenient manner. This feature has other important aspects as well, making the table useful to hold materials such as fiberglass sheets being prepared for laminations, to flatten or hold whole or partial pieces of paper or textile artifacts while being assembled or treated, and in general providing a highly useful work aid. All entirely without a pressure upon the surface of the work.

In use, the Electroplaque Hot Table can serve a variety of functions. When a penetrating adhesive is used to correct extensive flaking or to reconstitute internal cohesion of canvas, paint, or ground layers only, the process can be carried out on the table heated to the activation temperature of the adhesive, together with employing the static hold, which will maintain the painting in proper flat attitude, and aid in returning curling paint chips to their proper position. Lining can be also effected concurrent with this step. Or, if a painting has been flattened in a mechanical strainer warming, as described previously, under tension, together with electrostatic attraction will aid in the flattening process without imposing surface pressures while the painting is still mounted in the strainer.

Although not envisioned for uses other than on paintings, it has been found to have advantages that can assist the paper conservator in flattening, holding, assembling or attaching paper articles to reinforcing supports as required. This is also true for textiles. In addition, the capacity of the table to hold materials firmly in place without an impeding cover makes it

useful in the preparation of many restoration materials that must be held down flat while being worked on. The heat function is often useful in this regard.

An alternate electrostatic function can be obtained on ordinary vacuum hot tables by converting from vacuum beneath a membrance through holes in the table top to vacuum take-off through the cover. The Electrostatic Hold cover is a three layer "sandwich", the upper and lower layers of ½ mil polyester (Mylar or Melinex), the lower layer slightly larger, the center layer is a piece of fiberglass cut slightly smaller than both polyester sheets. Make the "sandwich" of ample size to permit repeated use on paintings of various sizes. The simplest way to adapt vacuum is to make vacuum jumpers of quarter inch copper tubing fitted with rubber suction cups at both ends. There must be four jumpers, one placed over each vacuum port in the table's corners, long enough to reach over the edges of the cover to a point just within the corners of the center fiberglass layer, the ends bent down about three inches with suction cups affixed. (If the table does not have four vacuum ports, other means of modification will have to be used, since four lines are required to achieve optimum efficiency of the electrostatic function). With the vacuum jumpers in place, the <u>upper</u> polyester sheet <u>only</u> is punctured as indicated, and vacuum will be transmitted from the port to above the cover. In this technique vacuum plays no part in downward pressure, but merely draws air through the layers causing constant friction within the sandwich, and attraction against the table top. (See references).

Summary:

Each of the elements of this three part system can be used separately or in combination with each other as may be required by the condition of a painting. Those paintings that need only added support by lining do not have to be subjected to thermal or other mechanical stress, but can be lined without any equipment other than a prepared lining. In one instance a painting that had been rolled, but in otherwise excellent condition, was flattened on a mechanical strainer, all evidence of

rolling deformities removed, and did not even require lining. Many paintings have been treated for internal deterioration under electrostatic hold without any of the usual consequences of textural alteration. During the past year several difficult linings have been accomplished at the Metropolitan Museum of Art in New York using the silicone adhesive and mechanical strainer elements of the system with excellent results, and additional linings there are scheduled.

The advantage of this new concept is its intrinsic safety and versatility in treating a wide variety of problems associated with painting conservation without imposing unnecessary stresses on a painting, and especially in preserving intact the most subtle nuances of meaning in the unique method each individual artist employs to communicate with the viewer.

References:

Details on the technique of Electrostatic Hold on vacuum hot tables, and other papers by the author dealing with vacuum problems, research and test results, and further descriptions of equipment and materials described in this paper are covered in the following articles by the author, available on request:

Paper: Electrostatic Cling as a Pressure Source in Lining of Paintings. Lining Seminar, National Gallery of Canada, April 1976.

Paper: Electrostatic Hold as a Pressure Source in the Lining of Paintings. AIC Fifth Annual Meeting, May 1977.

Paper: Electrostatic Hold as a Pressure Source in the Lining of Paintings; A Preliminary Report. JAIC Vol.16, 1977

*Article: Electrostatic Hold: A New Technique for the Lining of Paintings. Technology and Conservation Magazine, Spring 1977.

*Paper: (Unpublished). Principles of Mechanics Applied to the Lining Process. 1977.

(Those marked with an asterisk* are recommended).

Additional information on the Electroplaque Hot Table and Mechanical Strainers may be obtained from the following company:

In the United States: The Simco Company Inc.
920 Walnut Street
Lansdale, Pa. 19446
Telephone: (215) 368-2220
Cable: Simcostat, Lansdale, Penna.

degrading elements in the atmosphere and help minimize damage from vandalism or travel.

The mounting of the painting is carried out using fabric strips attached to the front of the tacking edges with Parafilm M[2] or a Japan paper interleave brushed or rolled with 1 coat of BEVA 371[3]. The adhesive interleave is cut to the size of the tacking edge. The fabric strips are laid onto the adhesive and are sealed with an iron heated to 50°C and pressed against each area from 15-20 seconds. Fabric strips are attached as described along the tacking edge where extra material is necessary for the stretching operation (Figure 1).

The painting and attached strips are placed on the stretcher and held in place at the corners with long push pins (Figure 2). If an auxiliary fabric has been mounted on the stretcher the locations of staples or nails are marked on the strip lining to avoid overlapping.

A line is drawn also locating the edge of the original tacking margin. The painting is mounted on the stretcher using the fabric strip for stretching and nails or staples (conservator's choice) placed inside the drawn line to fasten the tacking edge and auxiliary strip in place.

After the mounting of the painting is achieved the strip lining can be removed; peeling, using a scalpel to help release the threads in the areas of the staples or nails (Figure 3). The Parafilm M should come away with the strips. Any residue can be peeled away or released with mild petroleum solvents.

Experiments:

Tests were made to determine the best adhesive for temporarily sealing the strips to the tacking edge of the painting. The tensile strength of the adhesive had to be equal to the task of stretching the painting, yet the adhesive had to have a low peel strength for easy removal. The adhesive properties had to be repeatable.

The ideal tensile and peel strengths were determined to be above 25 kg and below 30 gm respectively. Five adhesives were tested using the "Instron" Tensile Strength Tester - Model TM.

For the tensile strength test strips were prepared of fine linen. Each strip measured exactly thirty threads across (warp threads). Strips were adhered with the adhesives covering an area of thirty threads across (warp) and thirty threads down (weft). The five adhesives tested are as follows:

1. Polyamide tissue - Strips were adhered with three layers of Polyamide tissue at 110^{o}C for 7 seconds. (20 examples).

2. Parafilm M - Strips were adhered at 50^{o}C using an iron for 20 seconds with pressure. The release face of the parafilm was against the ironed side. (20 examples).

3. BEVA 371 - Strips were adhered with 1 coat of BEVA 371 on an interleave of Japan paper with a 50^{o}C iron for 30 seconds. (20 examples)

4. Rabin Mixture[4] (½ lb. PVA AYAA, ½ lb. PVA AYAC separately dissolved in 12 oz. of toluene, then mixed together with 1 teaspoon Microwax): Toluene (75:25) over two coats of "Lepage's" White Glue: Water (50:50) on one strip was adhered to a second strip at 50-54^{o}C, 20 seconds. (20 examples).

5. Rabin Mixture: Toluene (50:50) over two coats of white glue. Water (50:50) on one strip was adhered to a second strip at 50-54^{o}C, 20 seconds. (20 examples).

The samples were placed in the jaws of the "Instron" Tensile Strength Tester on either side of the adhesive bond. The load was increased until the bond released.

The peel strength test strips were prepared of the same fine linen. Each strip again measured exactly

thirty threads across (warp threads). Strips were adhered with five different adhesives along six inches of linen. The same five adhesives with the same preparations described above were used. Twenty examples of each adhesives were tested.

The two jaws of the Instron Tensile Strength Tester were placed on the strips above the adhesive, the machine was activated, and the load was measured as the bond released.

The results of these tests are as follows:

	Average Peel Strength	Average Tensile Strength
Parafilm	12.9 gm	4.48 kg
BEVA	19.8 gm	5.54 kg
Rabin 75:75 #4	82.3 gm	1.21 kg
Rabin 50:50 #5	12.8 gm	0.89 kg

The tests on the promatco Heat Set Tissue did not have adequate repeatability to gauge the average peel and tensile strength. The Parafilm M and BEVA 371 interleave both had adequate tensile and peel strength making them excellent adhesives for the process described above. For the 75:25 PVA mixture: toluene adhesive, the peel strength was high and the tensile strength was too low. For the 50:50 PVA mixture: Toluene adhesive, the peel strength was good but the tensile strength was too low.

Conclusion:

The strip lining method described above can be used for restretching paintings where a strong but small vestige of tacking margin exists. The reasons for such a remounting of a painting are numerous: to simply restretch a painting; to provide an auxiliary, unattached support; to mount a painting on a new stretcher; to correct defects on an original stretcher,

or to perform treatments on a painting from the back in the area of the stretcher.

The advantage of using this sytem rather than a conventional strip lining is that no excess fabric or adhesive is left on the painting once the stretching has been accomplished. The system is simple to use and reduces the potential for later damage or complications.

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1. Promatco Heat Set Tissue, Process Materials Company, Veterans Blvd., Carlstadt, New Jersey.

2. Parafilm M, American Can Company, Available from scientific supply houses.

3. BEVA 371 - Adam Chemical Co., P.O. Box 15, Spring Valley, N.Y.

4. "A Poly(vinyl acetate) heat seal adhesive for lining" Bernard Rabin, Conservation of Paintings and the Graphic Arts, Lisbon Conference, 9-14 October 1972, International Institute of Conservation of Historic and Artistic Works, p.p. 631-635.

SEPARATION OF A DOUBLE SIDED OIL PAINTING ON CANVAS; A CASE HISTORY

Pierre Boissonnas

A painting by Otto Morach in oil on canvas, measuring 74 cms x 109 cms, painted on both sides of the canvas. The paintings were dated 1917 and circa 1932. One side was flaking slightly. The purpose of conservation treatment was to secure the flaking and to separate the two paintings.

1. Preparation:

   Two sheets of melinex type S19 were coated with Beva 371. The melinex sheets were a little larger than the paintings. The Beva was allowed to dry fully so that there would be no penetration or staining of the painting, and the sheets were applied to both painted sides. The melinex that was to be used to remove the painting which was flaking needed to be used double to give additional strength; thus two sheets of melinex were glued together with Beva 371, and the edges were sealed with pressure sensitive tape, so that the melinex would not split.

2. The pictures were heat sealed on the vacuum hot table between the two prepared layers of melinex. The side that was to be removed completely was faced with the double melinex foil, and the single sheet of melinex was applied to the face of the other painting - the one which was to remain on the original canvas, and the side which was structurally stronger.

3. The impastos of the "good" side were protected with a cushion of polyethylene foam 4 mm thick. A sheet of zinc foil .007 mm thick was then coated thickly with wax (Lascaux Klebewachs 447-95, melting point 68°C). This was used to embed the impastos of the "good" side. The picture/melinex complex was then placed on the zinc foil, "good"

side down. The side that was to be removed was face up. This new preparation was then heat sealed on the vacuum hot table to attach the "good" side to the zinc foil.

4. <u>Division of the Two Painted Sides</u>:

When the painting was cold, the pulling apart could begin. The shear angle of the side to be removed was reduced by using the same angle on the side which was being retained with the original canvas. That is, while one hand took the double melinex plus paint layer to remove it, another hand pulled downwards over a table edge on the embedded face. There were some small impastos that had not been completely embedded in the melinex, so that while pulling apart, any areas which had not stuck fully to the melinex were immediately reattached with a small heated spatular.

In this way the entire painting was saved.

In future an even thinner melinex - the thinnest available - will be used to obtain the best adhesion around the impastos, and this will be layered together as much as necessary to provide the overall strength for pulling apart without crackling.

5. The painting that had been removed from the original canvas was then placed face down on a polyethylene foam sheet on the vacuum hot table to refix the areas of the paint which might have been slightly detached during the pulling apart. The reverse of the paint was lightly sanded to even it out. The original coloured chalk preparation which had been left behind on the original canvas was scraped down and carefully gathered together to make the filling putty for the removed painting. Then a very dilute solution of acrylic glue (Lascaux acrylkleber 498HV) was applied to the reverse to consolidate the partly powdered preparation.

6. Preparation of the New Canvas:

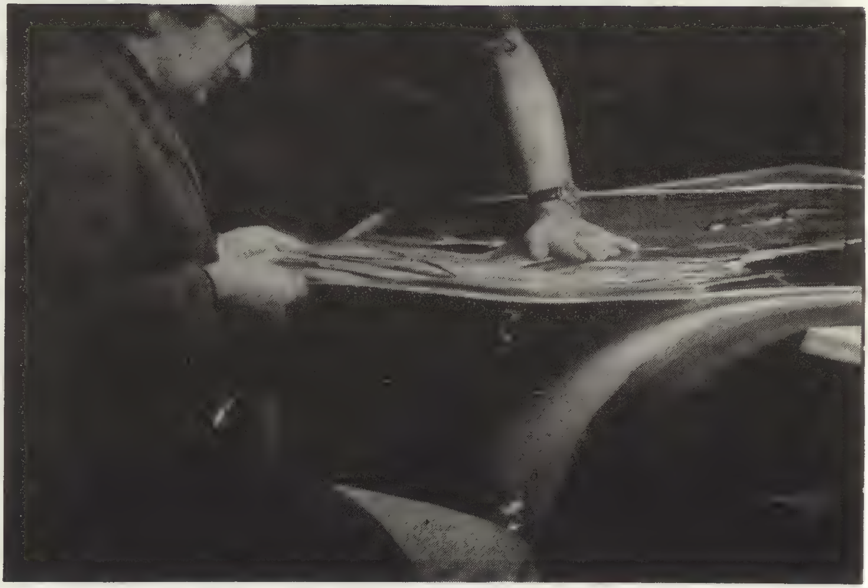
A pure linen canvas was washed and prepared and then stretched on to the Rigamonti adjustable stretcher. The canvas was primed with Lascaux priming and coloured to the original pinkish tint.

7. When this priming was dry an acrylic glue (Lascaux acrylkleber 498HV) was applied to the surface, and the detached painting was placed on it. To facilitate the drying and hardening of the glue and to encourage impregnation, we placed the painting and the new canvas under a cold furniture press. Two hours later it was removed from the press and some bubbles were noticed where complete adhesion of the paint had not taken place.

8. As this acrylic glue also has the property of heat sealing at about 50°C, we decided to put the whole stretching frame, backed with a heavy duty blotting paper, in a vacuum envelope. This was to flatten and reattach the loose parts and the bubbles. Four infra-red bulbs placed in a row on a stand were used as a heat source. To obtain even heat overall, a distancing stick was attached to the stand to maintain the distance between the bulbs and the paintings. The picture was divided into 5 cm areas and the stand was moved regularly across these. The heat was checked with thermo-papers on the front and on the back of the painting. This treatment was repeated twice.

9. Mineral spirit (white spirit, benzine) was used to dissolve the Beva facing and to remove the melinex.

10. The picture with the new canvas, and the other picture on the original canvas were then stretched on 2 new stretchers. The usual filling putty with wax was applied where necessary, and the paintings were varnished with B50 (acrylic varnish). After this, the retouching was completed in B40X (a softer acrylic resin). Final varnishing was with resin B50 again.



Horizontally tearing of the colour, while separating the canvas in bending down the zink sheet, on which the canvas sticks

A NEW LINING CANVAS

P. Parrini

(on behalf of Istituto Centrale del Restauro, Rome)

Summary

The problem of paintings relining is expected to find a solution by the use of a new canvas that allows glueing with traditional adhesives and offers an exceptional resistence to creep as well as high mechanical and elastic properties.

Such a canvas, which was produced by the alternative use of hemp and "Kevlar" yarns, the latter being a synthetic fibre based on aromatic polyamides and exibiting exceptional mechanical properties, was tested under different stress conditions even for very long times (up to 5000 hrs). It has been proved that, when well tight, it shows practically negligible size variations with time.

In addition to the properties of the fibres used, comparisons with other canvas known are reported.

Introduction

One of the major problems involved in the research concerned with the conservation of painting on canvas consists in their lining. Such an operation is required when deterioration of the original canvas prejudices the painted surface.

Extensive investigations have been carried out on such a phenomenon and on the various parameters affecting it from the outside(humidity variations,etc) and the inside(elastic properties of canvas)(I,2)

Supports based either on fibre-glass or on polypropylene have also been studied(I). Finally, straining on lining has been investigated on a mathematical basis with the purpose to establish which strains may be applied to the new canvas (3) and a non-destructive method has been set up for the determination of the elastic modulus of painted canvas (4)

Notwithstanding such effort and studies,no satisfactory solution has been found obviating the problems aroused by chemical degradation and mechanical relaxation, without jeopardizing the future of the painting or arousing further inconveniences. Hence it was decided to prepare a synthetic canvas combining the exceptional properties of the organic and high-modulus Du Pont fibre "Kevlar" and hemp adhesion to the classical canvas by traditional adhesives.

In this way a structure was obtained exhibiting the exceptionally high physical-mechanical and chemical resistance of "Kevlar" and the adhesion to the original canvas of natural fibre.

The properties and main characterisics of this new canvas are described in this paper.

EXPERIMENTAL PART

Canvas preparation

The properties of "Kevlar", a fibre based on aromatic polyamides produced by Du Pont, have been known for some years. In view of our goals the following properties were considered of particular interest: high tenacity and mechanical resistance(of the same order as that of steel) jointly with a considerable lightness (density lower than that of glass) and high resistance to"creep". Among organic synthetic fibres, "Kevlar" undoubtedly shows the highest resistance to stress due to constant load.

At first, we prepared an all "Kevlar" canvas exhibiting structural characteristics similar to those later adopted. In laboratory tests, such a canvas shown an excellent resistance, but in practical applications it appeared rather scanty owing to glueing difficulties by traditional adhesives, which are required not to jeopardize the life of the painting, and to reversibility of lining operation. This failure was attributed both to the low hygroscopicity of the new synthetic fibre(2,4% against I2% water absorption of hemp) and to the low affinity of the adhesives used.

Hence a canvas was prepared which might obviate such an inconvenience. Due to the over-abundant mechanical properties of "Kevlar" , it was thought that the introduction of a hempen yarn in the canvas would have avoided or at least largely reduced-as it actually did- all difficulties in glueing, without losing the advantages of mechanical resistance and especially of resistance to"creep" offered by the synthetic fibre.

Hence a canvas was prepared by alternating a "Kevlar" and a hemp yarn of the same count, both in weft and warp.Before transformation, the synthetic fibre was twisted at IIO twisting/metre.

The canvas obtained had the structural characteristics shown in Table I.

TABLE I

Structural characteristics of "Kevlar-hemp" canvas

Weight/mq		= 234 g
Weave		= canvas
N° of yarns/cm	weft	= 6,3
	warp	= 6,5
Yarns consisting of		= Kevlar(I780 dtex) Hemp (I650 dtex; IO Ne) Alternated I:I
Twisting of Kevlar		= II0/m of type Z
Density		= 40,9 yarns/cm^2

Mechanical properties and resistance to creep

The physical properties of the single fibres were determined according to the ASTM methods .The mechanical properties were determined from an average of 50 measurements by an Instron dynamometer, after conditioning for at least 24 hrs at 23°C and 65% U.R. The elastic properties were measured after applying a I% deformation.

Canvas characteristics were determined ac= cording to what described in (I). The mechanical pro= perties were measured by an Instron dynamometer on

strips 50mm wide and 350 mm long cut off both in the weft and warp directions. The values reported are an average of 20 determinations (IO / type).

Resistance to creep was measured by deter= mining the distance between two clamps at both ends of canvas strip 60 mm wide and 300 mm long , by a cathe= tometer. The values reported are an average of IO determinations, both in the weft and warp directions and were obtained in a conditioned environment, by applying different loads to the lower clamps in order to effect a stress of I330 g/cm or of 2000 g/cm or of 2660 g/cm.

Determinations were carried out soon after load application (time 0), then at increasing times (I hr, 2 hrs ,I2 hrs, etc) The same happened for measurements of deformation recovery (time 0 on load ceasing)

Comparison values were drawn from the data reported in (I).

RESULTS AND DISCUSSION

The mechanical characteristics of the new canvas are reported in Table 2 and compared with those of hemp, flax, glass and polypropylene canvas that are similar at least for weight for square-metre.

As may be noticed, the "Kevlar-hemp" canvas exhibits a quite higher tenacity and elastic modulus and a very narrow elongation. After a preliminary examination, the elastic properties seem lower than those of hemp, and not only of glass and polypropylene, which are notoriously quite elastic. However, also in view of the characteristics of the single fibres reported in Table 3, this may be presumably caused by a bad straining of the test-piece during measurement; that is why a first part of deformation simply affects the canvas structure and not the fibres constituting it. On the other hand, no fixing treatment with glues, resins etc. has been done on the canvas. This phenomenon seems proved by the subsequent creep measurements. The elastic properties of the new canvas probably are intermediate between those of "Kevlar" and of hemp, nay quite shifted toward the former.

Such excellent properties mainly derive from the new synthetic fibre as may be deduced from the characteristics shown in Table 3, where "Kevlar" and hemp are compared with glass and steel. Apart from its lower density, "Kevlar" exhibits higher tenacity and stiffness even than steel.

With regard to the elastic properties, the elastic recovery of the organic fibre is much higher than that of hemp and equal to that of glass and steel.Stress relaxation, instead, is slightly lower than that of the two inorganic fibres. Finally, its behavior toward water is excellent.

From the properties of the single fibres forming the new canvas and those of the canvas itself, it is possible to expect an excellent behavior to creep.This hypothesis is proved by long lasting measurements of resistance to creep, which supplied

TABLE 2

Mechanical characteristics of the "Kevlar"-hemp canvas compared with hemp°,flax°,glass° and polypropylene° canvas.The values obtained,all on untreated canvas, are an average between weft and warp.

	"Kevlar-hemp"	Hemp	Flax	US Glass	Ital. Glass	Polypro=pylene
Weight (g/mq)	234	286	234	203	2I4	232
Tensile strength (Kg/cm)	5I.I	20	2I.2	3I.5	35	32.5
Tenacity (g/cm/g/mq)	2I8	80	9I	I55	I63	I40
Elastic modulus(Kg/cm)	2450	I2I	20	4I2	I52	50.5
Elongation (%)	2.5	8	9.3	3.3	4.5	3I.5
Immediate elastic recovery after I% deformation(%)	50	77°°		88°°		9I
Permanent set (%)	I0	I4		3		0

°) Values are drawn from (I)
°°)Values of the elastic properties must be considered as indicative,since the other examined canvas are generally treated with adhesives,waxes,etc., while the "Kevlar-hemp" canvas have not undergone any treatment.

the results shown in Table 4 and Figs.I and 2. Mea= surements were carried out with three different · loads, two of which higher than those used on compa= rison canvas (2000 g/cm and 2660 g/cm).

As a first remark we may notice that deformation under stress is not affected by weight (after 600 hrs , elongation changes from I.I2% to I.37% although the applied load was doubled). In the case of a all hempen canvas, by doubling of the applied load, a I00% increase of deformation takes place(I). This fact suggests that the measu= red creep actually is very small and largely depends on the canvas settling on applying the load. Also the plot shown in Fig. I and 2 can actually justify such a statement.

Compared with the other canvas, the "Kevlar"-hemp composition shows a quite favourable creep both due to the low deformation and to the much longer time of load application. Creep tests, in fact, even lasted 5000 hrs, that is more than enough to supply a sure indication of its behavior with time (I). During that time, no increase in de= formation practically occurs (see Fig. 2), the canvas reaching the elongation values within the first I00 hrs mostly within the first minutes of load appli= cation.

Most deformation is immediately recovered on load ceasing; hence the structure has good elasti= city and does not undergo permanent set by the long lasting stress. Such a behavior seems particularly favourable in view of the purpose it has been built for therefore, by examining the characteristics of resistance to creep, it may be deduced that the new canvas is particularly fit for lining after being subjected to a convenient straining during operation.

The new canvas shows a deformation that is at least three times lower than that of the hempen one and even more than that of polypropylene (I); actually, in spite of its excellent immediate elasti= city,polypropylene does not show a good resistance to constant load.

TABLE 3

Physical characteristics of the single fibres forming the "Kevlar-hemp" mixed canvas compared with some of the most significant ones used for lining.

	Kevlar	Hemp	Glass	Steel
Titer (dtex)	I780	I580	3.5	2960
Density (g/cm^3)	I.44	I.50	2.5	7.85
Tenacity (g/dtex)	I7.I	I.7	8.4	3.2
Tensile strength(Kg/mm^2)	247	26	2I0	25I
Elongation (%)	2.4	I.7	3.2	2.2
Elastic modulus(g/dtex)	7I8	I00	277	I79
Elastic recovery at I% deformation (%)	99.7	35	99.7	99.4
Relaxation, after 60', to I% deformation (%)	92	67	I00	98
Flex life(N° of cycles)	2280	I20	0	-
Tenacity after 24 hrs in water(g/dtex)	I7.I	I.6	8.2	-

TABLE 4

Percent deformation at constant load undergone by the "Kevlar-hemp" canvas, at 23°C and 50% U.R.

Time of load application,hrs:	0	24	72	I68	320	600
Applied load						
I330 g/cm	I.03	I.08	I.I0	I.II	I.II	I.I2
2000 g/cm	I.08	I.I4	I.I5	I.I6	I.I6	I.I6
2660 g/cm	I.25	I.32	I.35	I.37	I37	I.37

Leaving out of consideration other properties such as weight and adhesion, the "Kevlar-hemp" canvas, compared with the glass one, shows a deformation of about I% against 0.4; such a difference may be easly eliminated by convenient straining. However, the new canvas offers far greater advantages ,such as ligh= tness, handiness and easy glueing.

CONCLUSIONS

By virtue of the exceptional mechanical and elastic properties of the Du Pont fibre based on aromatic polyamides and of the characterisics of hemp, a new 50:50 mixed canvas was prepared, which is par= ticularly fit for lining. As a matter of fact it should not arouse problems of adhesion to the old degraded cellulose canvas even by traditional adhesives,but thanks to "Kevlar" it should supply a tough structure that does not undergo deformation even for very long times. Such a coupling of the old with the new seems to lead to the realization of a material that perfectly fulfils the over particular requirements of the modern art of conservation.

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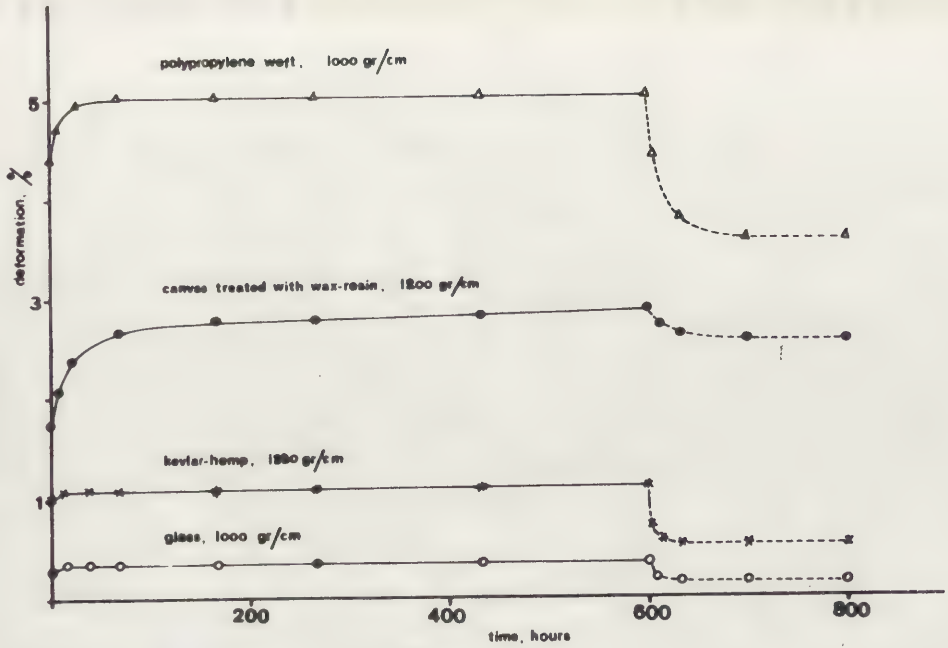
polypropylene weft, 1000 gr/cm
canvas treated with wax-resin, 1200 gr/cm
kevlar-hemp,
glass, 1000 gr/cm
deformation, %
5
3
1
200
400
600
800
time, hours

FIG. 1.

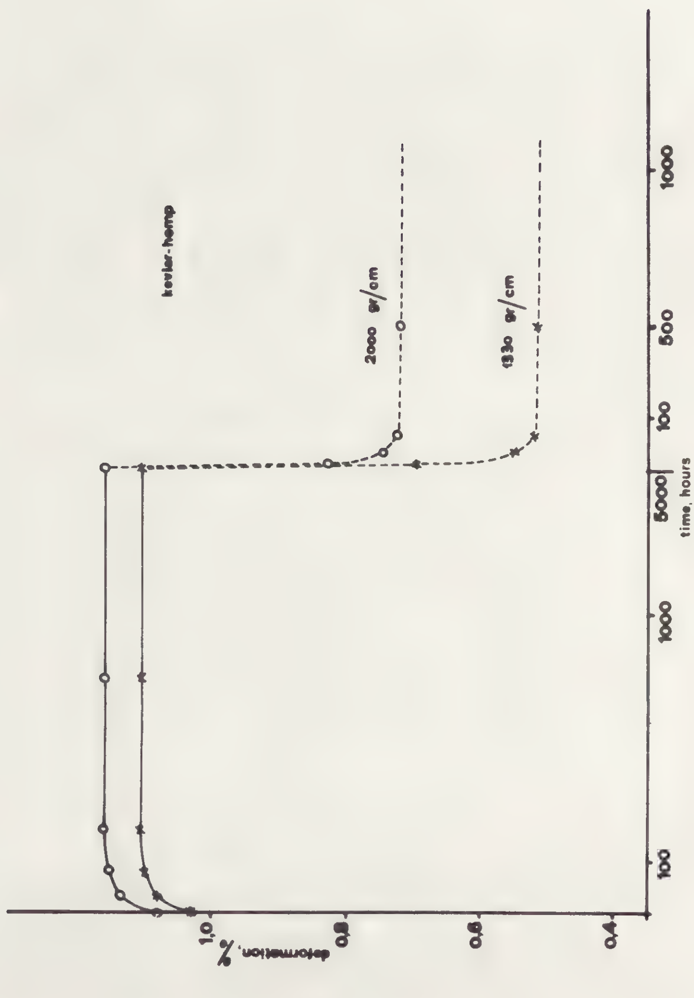
kevlar-hemp
2000 gr/cm
1330 gr/cm
deformation, %
1,0
0,8
0,6
0,4
100
1000
5000
100
500
1000
time, hours

FIG. 2.

THE PREDICTION OF STRESS RELAXATION AND INCIPIENT INSTABILITY IN LINING CANVASES

G. Ronca

INTRODUCTION

It is well known that lining canvases are subjected to a typical aging effect consisting in the formation of so-called"bags". Such bags are seemingly due to the viscoelastic relaxation of stresses in the canvas under the action of its own weight.

Recent experimental investigations (I) have been performed on the viscoelastic behavior of lining canvases. Creep experiments (i.e. at a fixed load) show that the "Creep Compliance" of a typical sample of a lining canvas can be written in the form:

$$J(t) = J_e + J_v t^{\alpha} \qquad \text{(I)}$$

where J_e is the instantaneous compliance and J_v and α are related to the time-dependent response of the material. In all cases taken into consideration α appears to be around the value I/3. Eq.(I) reproduces in its form the so-called Andrade Creep Compliance.

J_e and J_v have different values according to the direction of the applied load being parallel to the weft yarns or to the warp yarns.

In what follows we stress the information elements contained in Eq.(I) in order to predict the pattern of incipient instability in terms of local unloading effects for different pretensioning methods.

Two such methods will be considered:

I) rectangular sample pretensioned along the vertical direction and rigidly constrained along the horizontal edges.
2) rectangular sample pretensioned along the vertical direction and rigidly constrained along the four edges.

It will be assumed that the vertical direction coincides with one of the principle directions of the canvas(either weft or warp direction).

Next we will introduce some simple mechanical model of lining canvas.

From a mechanical point of view a canvas is to be considered as a two-dimensional structure, having strongly anisotropic characteristics. A general phenomenological model for an anisotropic membrane may be introduced, but it turns out to be an extremely complicated one if the underlying equations are to be solved analytically. For the moment a simpler structural model seems to be more convenient. We assume that our canvas may approximately be represented as a membrane for which orthogonal displacement components are decoupled. Denoting by x and y respectively the horizontal and vertical (upwards) coordinates of the sample, we obtain the following differential equations of equilibrium(limiting for the moment to an elastic analysis)

$$\beta\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) = 0 \qquad (2)$$

where β is the "rigidity" of the canvas and U the horizontal displacement component;

$$\beta\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) = p \qquad (3)$$

where p is the weight per unit surface of the canvas and v stands for the vertical displacement component.

Furthermore we must have at the free boundaries:

$$\frac{\partial u}{\partial n} = \frac{\partial v}{\partial n} = 0 , \qquad (4)$$

$\frac{\partial u}{\partial n}$ and $\frac{\partial v}{\partial n}$ being the directional derivatives along the normal to the free boundary line. A viscoelastic extension of Eq.(2-4) is straightforward.

RECTANGULAR SAMPLE PRETENSIONED AND RIGIDLY CONSTRAINED AT BOTH HORIZONTAL EDGES-

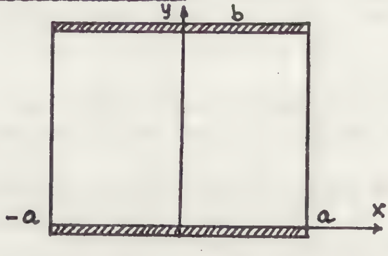

Fig. 1

Let us consider a vertical sample whose dimensions are 2a and b(see Fig. I). We assume that the given sample has been uniformly pre-stretched along the ver= tical direction so as to have:

$$v(x,b) = b \quad \text{for all } t \geqslant 0$$
$$v(x,0) = 0 \,, \tag{8}$$

where the instant t=0 corresponds to the pretension being applied.

Let us calculate at first the distribution of displacement and deformation immediately after the ap= plication of the deformation. Under these conditions the response of the material, being purely elastic,is completely characterized by the instantaneous component J_e of the Creep Compliance. We write therefore(see Eqs. I-4) $\beta = 1/J_e$.

The boundary conditions along the horizontal edges are given by Eqs.(8), while along the vertical edges we must have :

$$\frac{\partial v}{\partial x} = 0 \qquad (x = \pm a) \tag{9}$$

The solution of Eq.(3) satisfying all boundary conditions is :

$$v = p\,\frac{J_e}{2}\,y(y-b)+\varepsilon y \tag{I0}$$

The stability condition $\frac{\partial v}{\partial y} \geqslant 0$ requires that

$$\varepsilon - \frac{pJ_e}{2}(b-2y) \geqslant 0 \tag{II}$$

everywhere in the sample. Accordingly we must have $\varepsilon > p\frac{J_e b}{2}$. If this condition is not verified a "bag" is formed from the very beginning near the lower horizontal edge. However ,such a condition is certain= ly fulfilled in all practical cases.

As the deformation is applied, a relaxation pro= cess takes place. The force constant β must now be replaced by a relaxation modulus $\beta(t)$ (2). The equi= librium equation reads now:

$$\int_{-\infty}^{t} \beta(t-\tau)\frac{d}{d\tau}\left[\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right]d\tau = p \tag{I2'}$$

where $\beta(t)$ can be obtained from the Creep Compliance (I). Knowing the boundary conditions and the deformation history of the sample, we may solve Eq.(I2), e.g. by means of a Laplace transform over the time variable (3). As a result we obtain the vertical stress as a function of time:

$$f(t) = \varepsilon\beta(t) + \frac{p}{2}(2y-b) \qquad \text{(I3)}$$

Instability occurs whenever $f(t) \leq 0$ at some point of the canvas. We see from Eq.(I3) that such a local unloading effect is likely to appear at first near the lower edge of the sample. The critical unloading time t_0 is therefore given as a solution of the equation

$$\varepsilon\beta(t_0) - \frac{1}{2}pb = 0 \qquad \text{(I4)}$$

Eq.(I4) has always one single solution since $\beta(t)$ is a monotonically decreasing function of t. Assuming, as it is very reasonable in practice, that $\frac{\varepsilon}{J_e} \gg \frac{pb}{2}$, $\beta(t_0)$ can be written omitting the contribution of the instantaneous elasticity, and we obtain from connecting equation between viscoelastic quantities (4).

$$\beta(t_0) = \frac{1}{J_v}\,\frac{\sin\pi\alpha}{\pi\alpha}\,t_0^{-\alpha} \qquad \text{(I5)}$$

which, substituted into Eq.(I4), gives the critical time (for the case α = I/3)

$$t_0 = \left(\frac{3\sqrt{3}\,\varepsilon}{\pi J_v p b}\right)^3 \qquad \text{(I6)}$$

RECTANGULAR SAMPLE PRETENSIONED AND RIGIDLY CONSTRAINED ALONG ITS FOUR EDGES

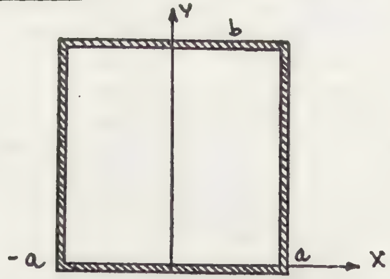

Fig. 2

The simple mathematical analysis developed in the previous section shows that any viscoelastic pro= blem can be transformed into an equivalent elastic pro= blem, provided Laplace(or Fourier) transform are intro= duced. Therefore we try to solve the elastic problem first also in the present case. As a result of this preliminary calculations we shall obtain the distri= bution of displacements and stresses immediately after the applied pre-deformation.

The boundary conditions are now given by

$$v(x,0) = 0 \quad (17)$$

$$v(x,b) = \varepsilon b \quad (18)$$

$$v(\pm a,y) = \varepsilon y \quad (19)$$

Solving the equilibrium equation (3) by the separation of the variables we obtain the vertical displacement field immediately after the applied initial deforma= tion ε

$$v(x,y) = \frac{1}{2} p J_e (y^2 - by) + \varepsilon y + \frac{1}{2} p J_e Q(x,y), \quad (20)$$

where Q(x,y) is given by

$$Q(x,y) = \frac{8b^2}{\pi^2} \sum_{1,3,5}^{\infty} \frac{1}{n^3} \left(\frac{\cosh \frac{n\pi x}{b}}{\cosh \frac{n\pi a}{b}} \right) \sin \frac{n\pi y}{b} \quad (21)$$

Changing now to viscoelastic results, we obtain during the relaxation of stresses

$$v(x,y,t) = \frac{1}{2} J(t) p \left[Q(x,y) + y^2 - by \right] + \varepsilon y \quad (22)$$

Furthermore we get the stress

$$f(t) = \frac{1}{2} p \left[\frac{\partial Q}{\partial y} + 2y - b \right] + \varepsilon \beta(t) \quad (23)$$

Equating Eq.(23) to zero and solving with respect to t for y =0 we obtain the critical time for the instability of the sample.

QUANTITATIVE DISCUSSION OF THE RESULTS

For the case of the laterally unconstrained sample we obtain the critical time in the form

$$t_o = \left(\frac{3\sqrt{3}\,\varepsilon}{\pi J_v p b}\right)^3$$

where ε is the pre-deformation to which the sample has been subjected, J_v is the constant of the viscoelastic component of the Creep Compliance (expressed in cm kg^{-1} $hour^{-1/3}$), p is the weight per unit surface of the system canvas + painting (in kg/cm^2) and b is the heigth of the sample.

Choosing:

$$\varepsilon = 10^{-2},\ b = 10^{2}\,cm,\ p = 10^{-3}\,kg/cm^2,$$
$$J_v = 0.0018\ cm\ kg^{-1}\ hour^{-1/3}\ *$$

Substituting into the formula which gives t_o, we obtain $t_o \simeq 7.3 \times 10^5$ hours, i.e. $t_o \simeq 90$ years.

If we let the height b of the sample increase to 2 meters, the critical time t_o is reduced to IO years and half. On other hand, reducing b to 50 cm we obtain $t_o \sim 700$ years. These results show that the vertical dimension of the painting has a great importance. The weight p per unit surface plays also a determinant role. We see that, reducing p by a factor two, corresponds to multiplying the time t_o by a factor eight.

We wish now to investigate the influence of the boundary conditions at both lateral borders. Making reference to a sample rigidly constrained at all its edges, we make use of the analytical solution given by Eq.(2I-23)

While keeping the vertical dimension of the painting fixed and equal to 10^2 cm, we have chosen three different values for its width : 2a = 60, IOO and I60 cm.

The results show that unloading occurs at first at the intersection of the lower edge of the painting with its vertical symmetry axis. The "time to instability" t_I is generally longer than that corresponding to the laterally unconstrained sample.

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* from the data of Conti-Tassinari(I) referring to a sample stretched along the weft direction (relative humidity 65%)

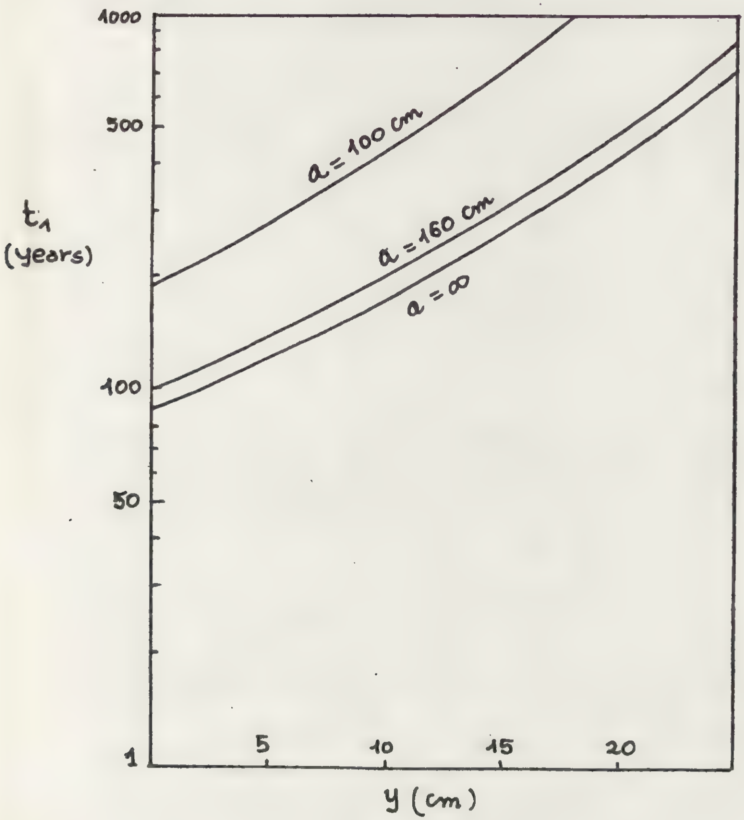


Fig. 3

In Fig.3 the unloading time $t_I(y)$ is reported for all points of the sample lying on the symmetry axis,as a function of the distance y from the lower edge of the painting.

Taking 2a = I60 cm we obtain a critical time for incipient instability which corresponds to 99.4 years (practically coinciding whith the free border result).

On the other hand for 2a = I00cm we have t_I= I90 years and for 2a =60 cm t_I= 6300 years. These results clearly show that constraining the painting

A LOW-PRESSURE APPARATUS FOR TREATMENT OF PAINTINGS

Bent Hacke

Abstract:

The article describes a low-pressure apparatus for treatment of paintings. In this apparatus it is possible to work at a low atmospheric pressure, the normal field of activity being about 500-1200 mm Wc (Water column), maximum about 1500 mm Wc. The work is done solely at temperatures below 45° C, and flattening, impregnation, and lining can be carried out as separate treatments or in succession. Aqueous adhesives were used formerly for impregnation and lining; now these have more or less given way to synthetic adhesives (acrylic resin). Special importance has been attached to the possibilities of individual treatment in the development of the apparatus. Thus the treatment can be adjusted to the individual painting by exchanging sheets, supports, etc. and various heating systems.
The apparatus/method which has already been used for a few years should be regarded as one of several possibilities, which, the harmful effect of the violent atmospheric pressure being realized, have appeared lately as an alternative to the hot table.

In 1964 the present writer published the article: "An Untraditional Method for Lining of Tempera Paintings on Canvas under Vacuum Pressure", in the periodical, "Meddelelser om Konservering", edited by Nordisk Konservatorforbund, IIC, Nordic Group. The method described was in principle based on the creation of increased atmospheric pressure on the protected or unprotected surface of a painting by means of an ordinary vacuum cleaner. The capability of the vacuum cleaner of rapidly removing relatively large amounts of air was utilized in direct conjunction with the traditional mounting on a framework for the establishment of this atmospheric pressure and the ensuing protection and control of the painting under treatment. The treatment included impregnation and lining in one procedure and was based on the use of glue and paste adhesives. Moreover, as appears from the article, the method was generally used in cases where the paint film was of an easily vulnerable nature (tempera, gouache, etc.) or, on the whole in cases where other special circumstances as regards materials excluded other known methods of treatment, including treatment on hot table. For a number of years the method was used with different experimental variations and so far quite a large number of paintings have been treated with absolutely satisfactory results.

For various reasons, however, it seemed necessary to perfect the system with regard to its function and relatively easy daily use in the conservation department: The apparatus needed improvements in itself, partly so as to allow of a more expedient and less time-consuming mounting, partly because certain technical problems had to be solved more satisfactorily.

The attempt to solve these technical problems gradually brought about

changes in the original, somewhat primitive working model and resulted in the construction of a simple, functional apparatus manufactured in several sizes, wholly based on the original principle and still with the frame structure as starting point. These are the most important characteristics of the apparatus:

a. Lining is carried out under low atmospheric pressure: Maximum 1500 WC (1500 mm water column per mm^2), the normal field of activity being about 500-1200 mm WC.
b. In almost all cases it is possible to work without covering with Melinex or a similar material over the surface of the painting, when it is considered necessary for the surface texture.
c. Flattening, regeneration, impregnation, and lining can be carried out as separate, finished treatments or in succession.

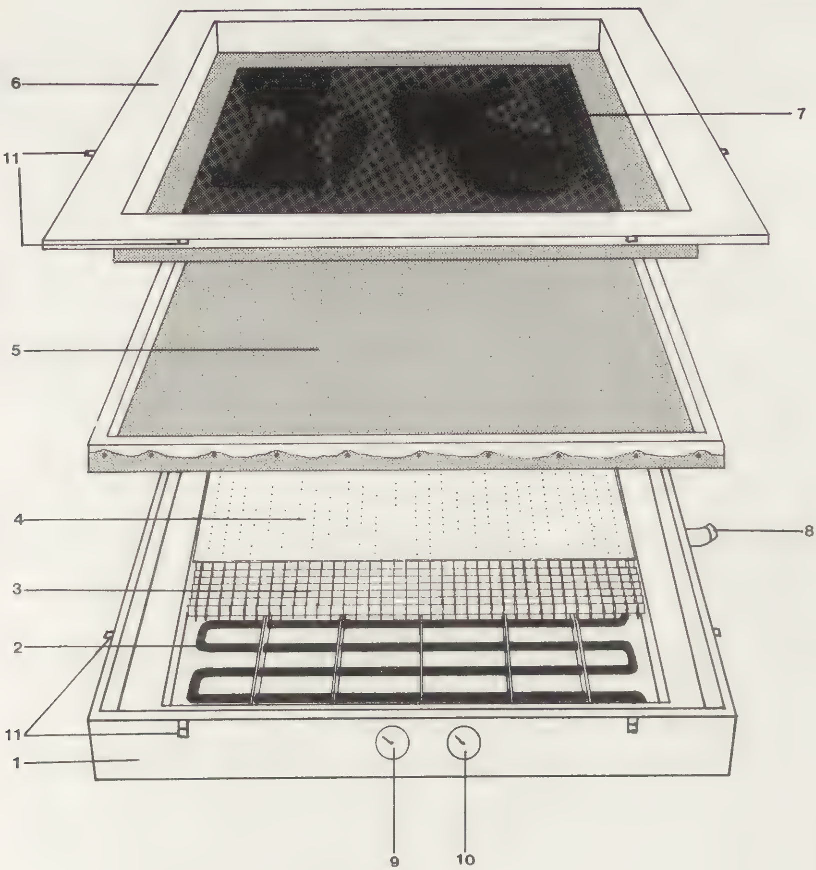
In connection with the treatment the influence of heat is employed, but in principle temperatures over 45^{0} are not used. Aqueous adhesives and paste are still in use, but due to their hygroscopic properties attempts will be made to replace them with synthetic adhesives. A few experiments have been made with application of wax/resin for impregnation and lining. This can be done, but a wider application requires changes of the apparatus. However, further experiments with wax/resin have not been carried out, the material not fulfilling the absolute requirements of reversibility and low temperature that had been made as a working hypothesis for the project.

The technical improvement of the apparatus and the particular possibilities of the method immediately resulted in an extension of the original field of activity so that, at the beginning, it came to comprise the treatment of a number of other paintings with sensitive and structurally problematic surfaces, especially paintings from more recent times executed in a variety of materials and techniques. Mainly paintings that defied treatment on hot table - as time went on a not inconsiderable number.

However, a fuller awareness of the harmful, changing influence of the high atmospheric pressure on the surface texture of the painting which it is almost impossible to avoid in spite of all precautions, has resulted in a wide extension of the field of activity so that the low-pressure apparatus is now to a considerable extent preferred to the hot table in the daily work in the conservation department.

The results of the treatment obtained during the past years have, in our opinion, generally been better than any method we have employed so far. Even after rather a long time of flattening, impregnation, or after lining the surface of the painting rarely shows signs of the treatment on immediate inspection. In addition, after the introduction of synthetic adhesives, it has become possible to maintain a large part of the original flexibility of the canvas after impregnation and/or lining.

Fig. 1. Diagram of the Construction of the Low-Pressure Apparatus.



Description of Drawing (Fig.1).

1. The bottom part of the frame structure made from 9 mm thick waterproof plywood. Air channels with extraction points built into the inside of the frame. Rubber tightening strips on the upper edge. Size, external measurements: 92 cm by 120.

2. Heating element embedded in aluminium bars form a heating grille, which also functions as bearing structure for aluminium lattice and metal sheet. Under the heating element an asbestos sheet about 5 mm thick.

3. Aluminium lattice functioning as flat base for the perforated metal sheet. (25 mm holes by 35).

4. Perforated brass sheets, hole diameter 0,5 mm, thickness 1 mm. Aluminium or alternatively copper sheets, of varying thickness and distance between the holes.

5. Frame with lining canvas stretched on to it fitting into the bottom frame structure. Size, external measurements: 90 cm by 115. Used only for lining.

6. The top part of the frame structure made from 9 mm thick waterproof plywood. Covered with Formica on the outside and inside. Size, external measurements: 92 cm by 120.

7. Painting mounted with paper borders attached to the edges of the painting and the outside of the frame.

8. Connecting piece for vacuum cleaner.

9. Low-pressure vacuometer. (Water column).

10. Thermometer.

11. Connecting fittings for airtight joining of top and bottom parts.

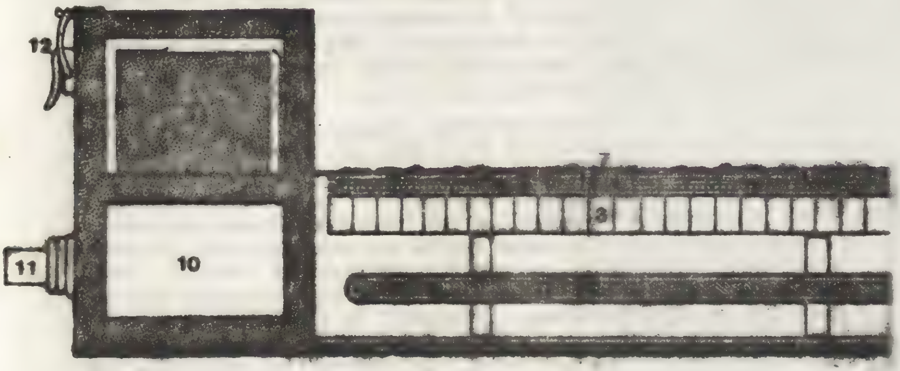
Two types of Nilfisk industrial vacuum cleaners are used:

a. Model GT 31, 220 v, 500 w, maximum vacuum: 1500 mm WC.

b. Model GV 21, 220 v, 500 w, maximum vacuum: 1500 mm WC.

These two types are in our opinion the most suitable for the purpose. Both of them are able to work without difficulties for many hours daily without interruption. Model GV 21 is able to remove water, if in special cases this should prove necessary.

Fig. 2. Cross Section of the Low-Pressure Apparatus.



1. The bottom part of the frame structure.
2. Heating element embedded in aluminium bars.
3. Aluminium lattice.
4. Perforated metal sheet.
5. Frame with lining canvas stretched on.
6. The top part of the frame structure.
7. Painting mounted with paper borders.
8. The support.
9. Bottomplate with asbestos sheet.
10. Air-channel.
11. Connecting piece for vacuum cleaner.
12. Connecting fitting.

On the Construction of the Apparatus.

The apparatus has been developed and functions according to the original principle, which, in brief, is as follows: The capability of the vacuum cleaner of rapidly removing large quantities of air is utilized to create vacuum in the apparatus under the back of the painting, pressure being created and exerted on the front of the painting.

This pressure can be maintained throughout the process of treatment by constant extraction of air, if it is considered necessary.

The construction of the apparatus has been aimed primarily at utilizing and controlling this partial vacuum, as it is appropriate to call it, because in a perfectly tight system it cannot exeed 1500 mm WC, which is the maximum capacity of the vacuum cleaner. Furthermore, the experiments were aimed at making use of the capability of the industrial vacuum cleaner of extracting aqueous vapours and at connecting a heat source of some kind.

For the sake of mobility the apparatus is made from a light material, and the individual components of the system can easily be lifted off, put away, or assembled and mounted where it is desirable. We have decided on using waterproof plywood, because it is a resistant material, which can quite easily be assembled and prepared. In all probability other materials such as aluminium or PVC can well be used. It has fully served our purpose to construct a prototype in several sizes in order thus to be able to select the suitable apparatus according to the dimensions of the individual painting. In this way we have obtained good tightness in the system and an efficient treatment.
For some time we have been working on the construction of a relatively large apparatus which would allow the treatment of paintings of most sizes, as on the hot table. It seems to be possible to solve the many technical problems connected with the application of the advantages of the principle to a large surface, but it calls for alterations in the construction of the prototype.
Furthermore, at the same time we intend to make an attempt to build a humidifier into the apparatus (see the passage on flattening).

Alternative Possibilities of Treatment.

In developing the apparatus great importance has been attached to the creation of a number of alternative possibilities of individual treatment. In addition to the normal regulation of heat and pressure of the hot table the apparatus contains the following possibilities:

1. The sheets under the back of the painting can be changed according the type and purpose of the treatment.

In the apparatus primarily metal sheets of varying thickness, with holes of various intervals are used. To avoid the risk of a pattern being left on the painting, the diameters of the holes should not exceed 2 mm. Other kinds of material may be used for sheets, for example polyethylene, wood, or rubber with or without perforation, in which case, of course, heat must be applied from the front only. An exeption, however, are special polyethylene sheets, which are both permeable to air and heat-conducting. These sheets have been used successfully in the treatment (flattening) of paper.
The thickness of the metal sheet affects the speed of the heating and cooling and the heat distribution. The diameter of the holes and the interval between them affect the speed of the drying process.

Practical examples:

a. If a high concentration of moisture is used in the treatment, as

during impregnation with aqueous adhesives or during glue-paste lining it may be expedient to use a thin metal sheet (brass, copper, aluminium) with a dense perforation and a small hole-diameter, which will result in rapid heating and cooling and rapid removal of exessive moisture in the material.

b. If a relatively small amount of moisture is used, e.g. at the flattening stage and if a slow heating and cooling process is preferred, it may be expedient to use a thin aluminium sheet with a small hole-diameter and greater intervals between the holes.

c. If synthetic non-aqueous adhesives are used for impregnation and/or lining, the metal sheet is to a higher degree chosen according to its ability to distribute heat and from a wish to obtain a rapid or slow working process. In this case a sheet without any holes at all or with minimal perforation may be used, provided that a felt support or the like under the back of the painting acts as an air channel.

2. The support is variable.

A support is used under the back of the painting at all stages of treatment, in our experiments mainly canvas and felt have been used.

The support has three purposes:

a. to act as an air-conduction element between the sheet and the back of the painting.

b. to act as a humidifier of the original canvas when necessary, i.e. the support is moistened adequately and through the influence of this moisture from the support the painting is softened during the flattening. If, in contradistinction to that, it is desirable to speed up the drying, this may be done by frequent replacement of the support with dry, absorbing supports.
During recent years, this more "direct" way of moistening the original canvas has been changed into an "indirect" one, which works by means of evaporation. By this method we have achieved much greater effect and better results than before, and, at the same time, the risk of undesirable stretching of the original canvas has been reduced considerably (see course of treatment: flattening).

c. to act as an interleaf, i.e. to eliminate any possibility that changes in the surface texture may arise in spite of the low atmospheric pressure.

Individual considerations of the kind and texture of the painting govern the choice of the character of the support. Other materials than felt and canvas can be used, e.g. nylon net, fine silk, non-woven fibre-glass and Japanese tissue. Apart from the thickness, the absorption capacity, the softness and texture of the material are of importance to the selection. Materials with a marked texture can be used under no circumstances, experience having shown the risk that these may leave a pattern on the original material, even at a very low atmospheric pressure.

3. Various possibilities of heating.

Economic conditions permitting, it is of course possible to build in or connect heating systems of a more advanced type such as exist on the market in many variations today. Brief mention will be made of a heating system which we have built into the system recently, in order to bring it to perfection. At the same time we will point out some possibilities which are technically practicable and not too expensive; simple devices which we still use in the system.
It must be emphasized that even though treatment with heating exclusively from above is possible, the best results, however, are achieved by means of heating elements which, placed at the bottom of the apparatus, heat the back of the canvas.

Built-in heating systems.

a. A modular heating system.

In the course of time we have made a great many apparatuses of various sizes, so in order to avoid constructing a special heating element for each individual apparatus, we found it expedient to get a number of heating modules, which can be used in all apparatuses, and be moved from one apparatus to another without difficulty. They were industrially manufactured after a design and description. A brief description: Steel-boxes in which heat-conduction wires are suspended. They all have the same dimensions (50 x 75 x 3,5 cm) and they can be connected. An aluminium lattice is mounted on the individual module. The elements are thermostatically controlled by the same control unit they are equipped with a phial and the temperature of the individual module can be read during the restoring process. The heating modules can be used when constructing very large apparatuses.

b. A simple heating system.

Before we introduced the modular heating system, we used, and still use, a very simple heating system constructed specially for every apparatus: Silicone-covered heat-conducting wires were passed through copper pipes which were run through flat aluminium bars. In this way a "heating grille" is produced, which also functions as bearing structure for the lattice and the metal sheet. An asbestos sheet is placed under the heating element and a thermostat with a phial connected with the metal sheet is inserted for regulation of temperature.

c. Application of heat from above.

Radiant heat derived from infra-red heaters can be applied from above. Also in this case the temperature can be controlled by using a thermostat with a phial, which can be placed directly on the surface of the painting.

d. Other possibilities of heating.

Mention may also be made of other possibilities of heating such as heated blankets or sheets, made from such materials as silicone or rubber, with embedded heat-conducting wire, heat-foil, hot-water bags, etc.

4. It is possible to work with or without a cover over the paint film.

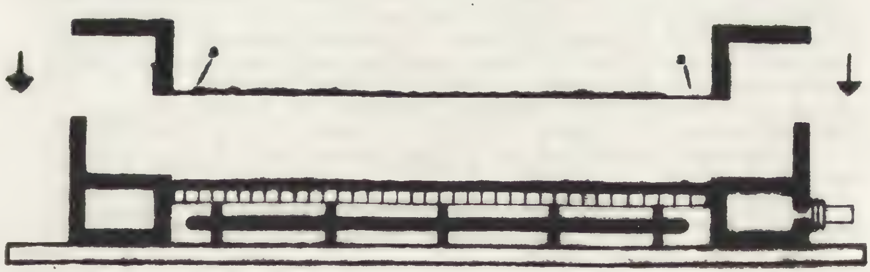
Although the apparatus can be operated without covering the paint film, it may, for several reasons, be expedient to use Melinex film as a membrane, when the paint film permits it, for instance when, after fixation, the paint film has been consolidated. This usually results in a slight increase of the pressure that may be useful in many cases. If the treatment takes place in air-polluted and dusty rooms, in which, for example, polluting work is being done near by, it is advisable always to cover the paint film with Melinex or the like. If, in particular cases, direct covering of the paint film is not possible because of the frailness or special character of the paint film, an air-filter should always be inserted over the paint film in order to prevent microscopic dirt particles from being sucked into cracks, holes, or other porosities in the original material. By way of example this can be done quite simple by placing several layers of gauze or some other finely woven fabric over the top frame during the treatment or, more advanced, by fitting a limpid plexiglass plate into the top frame with interchangable air-filtering material over inlet ports along the sides.

5. Operations of various kinds can be performed while the painting is under atmopheric pressure.

Throughout the course of treatment local areas can be subjected to various operations. Small rubber rollers, heated spatulas and the like instruments may be used, if paintings with particularly difficult crackling, bulging or other deformities require it. Furthermore, extra local or overall consolidation can be carried out successfully with adhesive from the front, if the condition of the paint film permits it. In order to ensure a better penetration of the adhesive, atmospheric pressure can be established at shorter intervals. In this way a better extraction of the air from the material in the paint film and grounding is ensured.

Description of a Normal Course of Treatment, including Flattening, Impregnation and Lining.

FIG.3.



1. Mounting of the painting. (Fig. 3).

Immediately when detached from the stretcher, the painting can be mounted face up by means of borders of paper pasted on to - and covering - the edges of the painting and attached to the underside of the top frame (fig. 3a). After that the back can be cleaned.

It has often proved to be an advantage to pre-stretch and pre-flatten the canvas, for instance on a wooden board, by slightly moistening the board and by attaching moistened paper borders. The contraction of the paper when drying ensures a taut and smooth stretching. When the paper borders have dried, the frame with the mounted painting is fitted into the rest of the system of frames and tightly attached to it by means of special closing fittings.

FIG.4.

2. Flattening. (Fig. 4).

Then the flattening may proceed, the painting being acted on by the atmospheric pressure as well as the heat and moisture of the apparatus. This is how the process is carried out:
A layer of moistened, closely woven linen or a similar fabric is placed between two perforated sheets under the support against the back of the painting. For moistening, water or, in some cases, combinations of water and solvents are used. During the heating, vapours will go up from the moistened linen through the support into the original canvas, and they have a softening effect on the canvas and the paint film. It can be expedient to establish pressure on the surface only when the moisture has penetrated well into the original material.
Serious crackling can be individually moistened directly on the back of the original canvas. The moistening effect will last for some time, even after the establishment of pressure (exsuction); it will therefore be possible to flatten crackling, bulging and other deformities gradually during one or more flattening processes.
During this process it is necessary to cover the borders of paper underneath with tight tape, in order to prevent the moisture from making the paper expand and in this way weaken the securing of the mounted painting.
In case of serious crackling, bulging or the like, it is often necessary, at the beginning of the flattening process, to cover with

Melinex-film or the like where this is possible, so that the moisture remains in the material longer, which improves the possibility of flattening. When satisfactory flattening has been obtained, the surface film can be removed and the picture will dry more quickly.

3. Consolidation of the paint film. (Fig. 4).

When the flattening is over, the paint film is consolidated. The top frame with the mounted painting is removed and adhesive is applied to the back. For this process both aqueous and synthetic adhesives can be used.
It is true of both treatments that once the original canvas, the paint film, and the ground have reacted to the effect of moisture (a reaction that can be controlled and maintained by vacuum), the picture in the frame can be dried and the treatment repeated as often as proves necessary.

4. Consolidation - flattening. (Fig. 4).

Especially when aqueous adhesives are used (in principle also synthetic) consolidation and flattening can be carried out in the same operation, and that will be preferable in some cases, e.g. when it is a question of fixing, consolidating and strengthening a paint film rather than straightening or flattening deformities, etc.

FIG. 5.

Lining by application of paste adhesives. (Fig. 5).

The frame with the lining canvas stretched on to it is placed in the frame system. The lining adhesive is applied in advance to a marked out section the size of the painting under the original canvas as well as to the reverse side of the painting, if the paint film and the original canvas are considered sufficiently consolidated to stand the mechanical effect. Otherwise, adhesive is applied to the new canvas only. In most cases it is possible to apply the adhesive to both surfaces after a careful preliminary treatment. Then pressure is established as in the case of the previous treatment. The painting is now gently heated and due to steaming of the lining liquid the action of this heat has a further conserving effect on ground and paint film.

Fig. 8.

6. Drying (Figs. 5-6).

The drying is always carried out under pressure. The space of time needed for drying is individual and depends above all on the structure of the painting, i.e. density of paint film, ground and canvas, but of course also on the amount of heat applied. Normally it is possible to finish all courses of treatment within very few hours, provided that the surface of the painting is not covered by Melinex-film or the like during the whole process.

Flattening, Impregnation, and Lining by Application of Acrylic Resin.

When acrylic resin is used for impregnation and lining, the course of treatment is still the same as described above, however, the painting need not necessarily be attached to the top frame with paper borders, and the lining can be carried out without the lining canvas being stretched on to the frame of the apparatus. Flattening can be carried out immediately after the cleaning of the back, but also after impregnation with acrylic resin. The latter method is preferred in many cases, because stability in the material is obtained immediately without further treatment being made difficult.

The lining canvas is stretched and 2-3 layers of Plextol D 360[2] with an admixture of diluent Rohagit SD 15[3] are applied. The layers are applied only to the lining canvas.

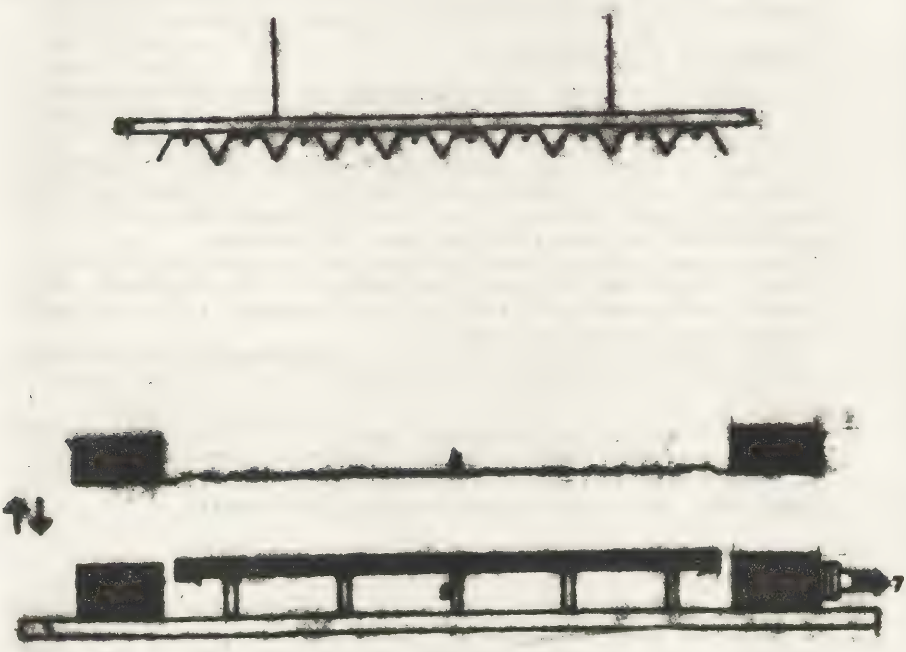
Finally, it should be pointed out that by application of both adhesives it is possible either to work according to the normal procedure described above or to work with the original and lining canvases lying unattached to the frame in the apparatus. In the latter case the method is a simplified one, which permits a greater freedom of operation and flexibility in the treatment. It should be stressed, however, that this method is advisable only when synthetic adhesives are applied. If aqueous adhesives are used, the normal course of treatment as described above is followed, especially because the stretching of both painting and lining canvas is an extra precaution against reactions that might possibly arise in the material due to the influence of moisture.

1. Plexisol P 550 is a pure acrylic resin diluted with white spirit. It is usually (depending on the circumstances) applied in a 10-30 per cent solution for consolidation of the paint film.

2. Plextol D 360 is a pure acrylic emulsion on waterbasis.

3. Rohagit SD 15 is a thickener for acrylic emulsion on a Polymethacryl acid basis. A 5 per cent admixture gives a paste which can easily be applied.

Fig. 7. Cross Section of a Simple Construction for Treatment with Acrylic Resin and Glue and Paste Adhesives.



1. Table.
2. The lower frame.
3. The top frame.
4. Panel covered with felt.
5. Support for panel.
6. Painting mounted with paper borders.
7. Connecting piece for vacuum cleaners.
8. Infra-red heater.

The space between the two frames and between the lower frame and the table top is sealed with tape.

A simple Construction for Treatment with Acrylic Resin and Glue and Paste Adhesives. (Fig. 7).

If means and circumstances permit nothing else, the system submitted here may in principle be constructed relatively simply on the lines of the original version, which forms the basis of the prototype and yet is employed with satisfactory result, even at the treatment of very large sizes.
We have carried out flattening, impregnation, and lining of very large paintings with this simple system, without having had much difficulty in maintaining sufficient pressure.
However, we have found that it may be necessary to use two vacuum cleaners if the painting is larger than 5 square metres. It should be added that the drying may be very slow, in any case the supporting sheets must be changed frequently.

Treatment of Paper and Textile.

To a certain extent the apparatus/method has been used successfully for treatment of paintings and drawings on paper, and oil, tempera, watercolour, etc. on paper of various kinds and thicknesses. The treatment is carried out on the lines described above as regards flattening and lining. In most cases the density of the paper will render covering with Melinex film or the like superfluous, and it will be sufficient to cover along the edges of the paper.
It has proved to be very difficult to find a support which does not leave a pattern on the paper under treatment. We exclusively use a smooth, soft polyethylene sheet which is permeable to air and moisture and heat-conducting as well.
It should be pointed out at once that no experiments have been made with a view to treating textiles on these lines. This of course should be left to restorers of textiles under any circumstances. However, in my view the technique, possibly with minor changes, could be applied to this field as regards flattening, consolidation, as well as lining. It would be interesting if specialists would attempt this, thus confirming or rejecting this theory.

Conclusion.

The utilization of atmospheric pressure in connection with treatment of paintings meant a fundamental improvement and extension of our possibilities. For many restorers the hot table came to play a decisive part as an ideal instrument, by means of which many treatments could be carried out better than they used to be and at less risk. Naturally the hot table is still an extremely important instrument in our work, but as is always the case, drawbacks and advantages become quite evident only after prolonged use. The fact that, due to our enthusiasm, we may not always have been sufficiently aware of the changes that can be caused in structure and surface texture by the violent atmospheric pressure in particular and also by the high temperatures is perciptible on the surfaces of the paintings.

Experiments have shown that these changes in the surface cannot pos-

sibly be avoided on the hot table in its present version, and furthermore that it is difficult, perhaps impossible, to improve them. Although the project described here must be considered as having reached beyond the experimental stage in the light of the many years of experiments and practice, it should after all be looked upon as an attempt to evolve a method of carrying out necessary treatments without changes in the original texture. It should be judged as one of several possibilities, which have recently been submitted and which, no doubt, will be presented within the next few years. It is of supreme importance to me that there is a number of alternative possibilities, some offers that can be selected according to the demands for individual treatment made by the object in question.

These experiments will now be carried on, partly because the need for changes and improvements will continue to arise along the road, partly because other possibilities of treatment are to be examined more closely.

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ETHNOGRAPHIC MATERIALS

Coordinator : W.P. Bauer (Austria)
Assistant coordinator: H.V. Gowers (U.K.)
Members : A. Bakken (Norway)
K.A. Fritsch (Fed. Rep. of Germ.)
G. Gall (Fed. Rep. of Germany)
B.Gibson (U.S.A.)
D. Idiens (U.K.)
R.B. Renshaw Beauchamps (Canada)
H. van Geluwe (Belgium)

Programme 1975-1978

1. Storage conditions: new methods, renovation problems, new materials (Idiens, Fritsch and others).
2. Pest control ; fumigation (different methods, different gases, effectiveness, testing new fumigants, safety precautions).
Methods and materials for permanent effect: insecticides, fungicides, bactericides (Bauer and others).
3. Preservation of hairs and feathers: cleaning, consolidation, restoration (Gowers, Gibson, Gall).
4. Conservation of bark cloth: cleaning, and conservation treatment, special storage problems (Bakken and others).
5. Treating of painted surfaces: cleaning, colour fixing, consolidation, aesthetic aspects of restoration (Bauer, Gowers and others).
6. Publication of working papers (list of literature and index of publications of conservation of ethnographical materials) (Fritsch).

REPORT ON THE ACTIVITIES OF THE WORKING GROUP 'ETHNOGRAPHIC MATERIALS' (1975-1978)

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In the following report a short summary is give of the main activities of the working group "Ethnographic materials" during the last three years. The first work after the Venice-meeting was to reconstruct the working group. At the meeting in Venice 1975 the working group could be hold only a short meeting. Many contacts had been lost since the meeting in Madrid 1972. In spite of this a vivacious discussion among the participants arose about special problems in ethnographic museums. It was stated that there is an excessive lack of good methods of conservation of basketery work as well as of leather and animal skin in ethnographic collections. Furthermore, principles of good house-keeping, particularly in small ethnographic museums were requested: this involves also effective methods of pest control. A further question was, how to rebuild or reconstruct an old museum in the best way.

Good house-keeping and pest control

It is well known that much unnecessary work as well as damage caused by insects can be avoided by the adaption of proper preventive methods. One of the most reliable methods of keeping collections and exhibits free from pests is the fumigation of all newly purchased materials and of all objects that come into the museums from travelling exhibtions. Particularly ethnographic collections usually contain a large number of objects made of organic materials which are susceptible to insect attack. But insect attack does not only start in the country of origin of the object; insect attack also occur very often in the museum itself. Therefore a fumigation of all objects acquired by museums and at certain intervals of all objects which are stored in the museum should be done as a routine precaution in order to prevent infection.

For an effective fumigation it is necessary that the lethal gas applied kills all insects in every stage of their development. The most commonly used gases are: methyl-bromide, ethylen oxide, hydrogen cyanide. Under vacuum and with circulation-system the effectiveness of the fumigation can be increased and the time of the fumigation shortened. Two papers of this meeting are dealing with this special field of work, which is of general importance for ethnographic museums all over the world.

The rebuilding of an old museum

Special problems arise when an old museum must be rebuilt. It is very important that already at an early stage in planning conservators and rest o rators together with the architects work out the plan of the new building.
From the technical and conservational point of view special attention must be paid to an improvement in the climatic conditions (relative humidity, temperature) and light in the museums, to storage rooms with more suitable cupboards, bookshelves, movable shelves. These are factors of prime importance. In practice, this means that efforts must be made to maintain the relative humidity within specified limits (i.e. 50-65 per cent at 18 - 22 °C). Ideally this can be achieved by a complete climatic installation but perticularly in older buildings alternative methods of humidity control can be adopted.
When planning the rebuilding of a museum one must also take care to complete as well as to improve the restoration facilities and the chemical laboratory.
In this connection Mr. Fritsch reports about his practical experience in the rebuilding of the Übersee-museum in Bremen.

Conservation of basketery work and leather

Another problem needing special attention is the conservation of basketery work and of leather in ethnographic collections. A great number of objects in ethnographic museums are items grouped under the terminus basketery work, wicker work and so on. In the course of time these materials, which consist of plant fibres, often suffer from dry climate in the store roomes (with low relative humidity), air pollution or dust as well as from bad storage and damage in transport. The fibres become very brittle and dust makes the objects very dirty; thus they are delicate items for the curators in the museums.
Arne Bakken and Kirsten Armo (Oslo) developed a method of conservation to restore flexibility and simultaneously to strenghten these fibres; they also described a method for cleaning and repairing.
Similar to basketery conservation the curator has to take care of leather objects which are exhibited or stored by protecting these objects from decay. A paper from Werner Schmitzer (Leder-Museum Offenbach, BRD) reports on newly developed methods of conservation and restoration of leather. He gives instructions for dry and wet cleaning methods and recommends products for lubricating old brittle leather work. Generally we can state that leather which has been treated with fat and little wax gives better conservation results than leather treated only with wax products. Leather needs fat for nutriment in exact dosages in order to remain flexible.

I am very grateful to the autors of the papers for this meeting for showing so much interest in their work and spending so much time in preparing a paper. They are qualified in their special fields of work, and I hope thatb the discussion of their papers will provide all curators in ethnographic museums with a better understanding of the conservation of cultural property.

'FUMIGATION': TO PURIFY WITH FUMES

R.B. Renshaw-Beauchamp

"Fumigation" is an attempt to explain, in as non-technical a way as possible, how to free a building of pests which might damage the collections and how to keep it that way. The total fumigation of a building and the possible fumigants are discussed. Basic pest control rules which all the staff should observe are laid out. Finally, differing methods of artifact "fumigation" are set out and the most advantageous circumstances under which they should be used discussed. Plans for a walk-in and a small fumigation chamber as well as safety procedures, details of fumigants and a short bibliography have been included as appendices.

This paper is not written to inform or instruct the professional conservator. It is aimed at the small museum or the new museum where staff have no formal conservation training and little likelihood of being able to employ a conservator. By definition a curator must care for his collection. Fumigation and thus the control and elimination by fumigation of damage caused by insects is a basic concern of all curators and museum staff.

("Mens sanis in copore sano"). Which being roughly translated could be "a clean collection in a clean museum"). It is of little use fumigating your collections if they are going to be re-infested from your building structure. Furniture and Powder post beetle as well as termites can be at work in the fabric of the building, unknown to all but the expert. "Termites a world problem", and "Pest Control in Buildings" by Norman E. Hickin from the Rentokil Library are two books which deal with this subject in depth but in terms comprehensible to the layman. Termites are not generally thought of as a hazard to to museum collections, they are. I have seen the ravages caused by these insects in Archival Material as well as wood. Their control should be by professional pest control people. However, the Director or whoever is in charge of the museum must know the method which will be used and the fumigant to be employed. A complete evacuation of all material from the museum will rarely be practical or possible, but, if methyl bromide is going to be used, it should be remembered that the following materials should not be exposed to the gas or liquid:

1. Iodised salt, stabilized with sodium hyposulphite
2. Salt blocks and for animal licks
3. Certain soap powders and baking sodas
4. Sponge rubber
5. Foam rubber (as in rug padding, pillows, cushions, mattresses etc.)
6. Rubber stamps and similar forms of reclaimed rubber
7. Furs, horsehair and pillows (especially feather pillows)
8. Leather goods, particularly white kid and natural history specimens which may have been tanned by a sulphur process or process containing sulphur
9. Woolens particularly Angora
10. Viscose rayons, made by a process that uses carbon di-sulphide

11. Cinder block or mixed concrete and cinder block (your building perhaps?)
12. Charcoal, which not only becomes contaminated, but absorbs great amounts of methyl bromide and thus reduces effective fumigant concentrations
13. Paper that has been cured by a sulphide process and silver polishing papers. (Newspapers and much recent Archival material)
14. Photographic chemicals - not including cameras or films
15. Rug padding
16. Any other materials that may contain reactive sulphur compounds.

It is stated that methyl bromide softens natural resins. The Author has fumigated much furniture and many paintings with this fumigant. While the resins may be softened in high concentrations during the fumigation no evidence has been brought to light, to his knowledge, that they are degraded, nor have any damaging effects been noticed. Dammar resin on a painting has not sagged. Drawers in a French polished chest-on-chest have not stuck. If furniture was piled up or a soft cloth was pressed against a painting coated with a natural resin, damage might ensue, however, common sense in stacking must be used. As can be seen methyl bromide does have its draw-backs but if used properly, the building well enveloped in plastic, the ambient temperature never less than (70 °F), 21°C, the amount of fumigant not less than 1lb. per 1000 cu. ft. preferably 2lbs. per 1000 cu. ft., the fumigation continued for at least 24 hours with proper gas circulation, everything living in the building will be killed. Insect eggs, larvae, pupae and adults will be eliminated. Vikane, a trade name for sulphuryl fluoride, may be used for this type of fumigation. It is a colourless, odorless gas, stable and non-corrosive. It is <u>phytotoxic</u>. In contact with water or steam it will react to produce highly toxic and corrosive fumes. It is approximately one third as toxic to humans as methyl bromide. The dosage for fumigation is the same, 1lb. per 1000 cu. ft. at 70°F. (21°C.) for 24 hours but double the dosage at <u>any lower temperature</u>. Once again every living thing in the building will be killed. It must be borne in mind that these treatments, while they leave a "clean building", do not confer any lasting protection. They are not residual. However, drywood termite colonies re-establish themselves very slowly.

The preservation and continual care of buildings is not part of this paper. However, it would be worthwhile for any Director to obtain a copy of : Termites - A World Problem by N.F. Hickin published by Hutchinson of London and "Pest Control in Buildings" by the same author and publisher. See appendix VII .

"What about the materials removed from a buidling while it is being treated?" You may well ask. Anything which can be put into a plastic bag or envelope should be so packaged and stored under shelter. How they should be dealt with is explained later in this paper.

Prevention rather than cure

Outbreaks of museum pests are more than a niusance. In many instances they can wreak irreversible and wholesale damage. All the fur or feathers may be eaten off a decorated object leaving only such minute traces of original materials that those materials can no longer be identified with complete accuracy. Wooden objects can be so undermined that tonal, color and even material changes have to be tolerated in order to stabilize the artifact. In these cases the integrity of the objects is compromised.

Good Housekeeping

No museum director should so stand upon his dignity that it is beneath him to examine minutely the housekeeping in his museum. Dirt, besides being of itself damaging to all classes of objects, attracts, harbours and protects museum pests. The museum director and his curators should make it a practice to inspect, with regularity and attention to detail, every area of the museum and most important, its immediate surroundings. A clean museum next to a garbage dump will soon have its population of rats, cockroaches, birds, flies, etc. Remember birds-nests harbour carpet beetles!! Storage areas are danger spots. They are or should be dark, all too often the ventilation is inadequate and all too often they are but infrequently visited by the curators and technicians. Given this neglect, especially in rolling, full space type storage, an ideal breeding ground is provided for such pests as clothes moths, carpet beetles, mice, etc. That such a thing could happen will be hotly denied by most, if not all, museum staff. If however, they were to search their consciences and memories they would admit I am right. As I sit here I have suddenly remembered that I have not looked at a bag of fur trimmings for well over 6 months. It should be alright, they are in a heavy plastic bag, tied and were brought into the lab "clean" (fumigated) but "should be" is not good enough. Collections must be regularly and systematically inspected by the Curator and/or his staff.

A most important area in a museum and one which 90% of architects will ignore if possible and which is one of the first areas to be cut if governments or trustees wish to economise on a building, is the holding room. No object, new or old, should enter the museum without passing through the holding room. This room should be situated immediately next to the entrance used to accept objects and freight. It must have its own ventilation, it must not be connected to the museum's ventilation or air-conditioning system. It will be very difficult to

impress upon staff that the rule of "no object is to enter the museum without inspection or fumigation" must be observed but it is one of the hard and fast rules that must be enforced if the museum is expected to remain "clean".

It must be apparent by now that the "Museum Restaurant" or "Coffee Shop" is to be discouraged at all costs and particularly if it is incorporated into the body of the buildings. Mice are destructive creatures and rats must gnaw to keep their teeth short or they die. Even objects with no nutritional value such as lead, pewter, or plastic are not safe from their predations. Coffee, tea, sugar, cookies, etc., kept in desk drawers, are to be discouraged and plants and flowers, though attractive, should be thoroughly inspected as they often bring with them adult carpet beetles (Anthrenus verbasci and Attagenus pellio/piceus). A very sensitive area is that of travelling exhibits or loan exhibits. The travelling exhibit is perhaps one of the most difficult sources of infestation to control. Only too often does it arrive the day of or the day before the opening of the special show, yet it must be "clean" before it can be mounted in your "clean museum". There will of course have been some advance warning and when it does arrive the holding room should be empty. A conservator or one of conservation's staff should then proceed to inspect all the objects; one case at a time. The objects should be removed from the case and the case and packing materials searched for any traces of pest presence. The objects should then be inspected and those that can be declared clean removed from the room. The same procedure should be gone through with each case. The remaining artifacts which cannot be declared clean (upholstered furniture, stuffed dolls, etc. etc. should be bagged*, and fogged*, presupposing you have no fumigation chamber). In the case of large objects they and the whole holding room will have to be fogged. Ideally, the objects should remain bagged until the following day and then the bags can be examined for any signs of pests which have removed themselves from the cover of the objects. At any rate, the adults and larvae will be killed and so you have a grace period of between 8-10 weeks before you can possibly have mobile adults again infesting the objects. If you are hosting the exhibit for longer, and cannot fumigate it in a chamber before exhibition, then the fogging should be repeated 8 weeks after acceptance into the museum of the particular exhibit. If there is a fumigation chamber available and the objects can be treated with methyl bromide then 24 hours in the chamber with 1-2lbs. of methyl bromide at 70°F+ will rid them of all pests including eggs. If Dowfume EB 5 is used then a minimum of 21 days in the chamber is necessary unless the objects can be returned to the chamber; this should be after 8 weeks on display as Dowfume EB 5 will not kill the eggs. If the artifacts are returned then 24 hours (minimum) will kill the larvae which have hatched from the eggs. Many staff members may think that if an object is only

* See Bagging
* See Fogging

in the museum for a short while, as little as an hour perhaps, then it can by-pass the holding room. This kind of loose and illogical thinking should be corrected quickly and finally.

If the opinion of the Director, Curator or Conservator is sought on an object brought to the museum by a member of the public, examination should be carried out in the holding room. If it is, for example, a piece of porcelain, then it should be unpacked in the holding room, examined wherever anyone likes, then repacked in the holding room and out of the museum with it - unless of course the owner wishes to donate it to the Institution.

This next part of the paper will present a variety of ways in which fumigation can be employed, several fumigants which have been used successfully by the Author, the limitations of the methods and the safety precautions which should be observed.

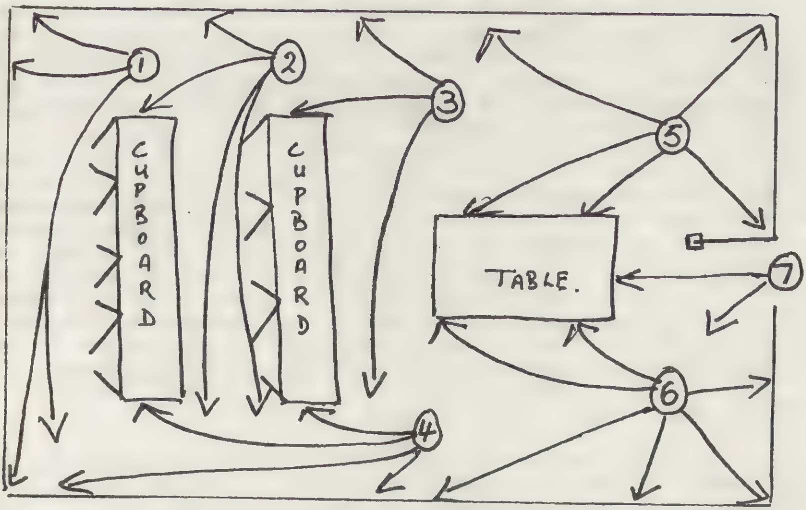
Fumigation Chambers

Appendixes I and II describe a large and a small fumigation chamber respectively. They are good plans. They work. I have seen them work and in the case of the small chamber, I have used one. Fumigants which can be used are methyl bromide (note the restrictions on page (2), Vikane - i.e. Sulphuryl Fluoride, or Ethylene Dioxide in an inert gas such as CO2 or Nitrogen. Many museums throughout the world contain fumigation chambers which cannot be used because of design faults. There is no excuse for this if one of the appended designs are used.

Fogging

A fog of microscopic insecticide/diluent droplets is distributed in an infested area by an atomizing "Fogger" i.e. spray machine. The droplets float for several hours and settle gently all through an area, penetrating anywhere where air can penetrate. Remember that unless a droplet can settle on a bug it will not be killed; boxes, drawers, cupboards, etc. must be opened. Providing that the recommended amounts of insecticide are used, the machine is working properly, i.e. producing a fog of small enough droplets, and a direct jet of fog is not aimed or directed onto an object, no staining will occur. The advantages of fogging are: 1) the operator needs no special training; 2) all he must do is read and follow the instructions provided by the equipment manfacturer; 3) it does not involve having a fumigation chamber; 4) the operator only needs personal equipment consisting of a canister, full-face respirator, rubber gloves and coveralls. Fogging can be carried out in sites as long as the doors and windows are taped shut and the ventilator apertures are sealed by polyethelene taped into place. The area should be left for as long as possible; at least 12 hours, preferably the weekend. It should then be well aired before re-occupation by staff. (See Appendix VI for equipment and supplies). That which you can smell is the diluent; the insecticide is odorless. When the fog has settled and the air is clear of droplets you will still be able to smell the diluent. Do not worry about this.

"Your fogging plan"



1. Plan your route so as to cover all corners and yet take the shortest way with no cord tangles. (At No. 7 disconnect Fogger and tape up door).
2. Secure door open.
3. Make sure you have rubber gloves, coveralls and respirator on.
4. Make sure you fog under and behind all furniture and heating apparatus. Do not miss the ceiling or any corner.

Bagging

An easy, cheap, effective way to fumigate even quite large objects. Quite simply, the object is put into an unpunctured plastic bag and the bag has the insecticide introduced into it. Perhaps the most effective insecticide for this purpose is dichlorovos, sold as Vapona Strip or No-Pest Strip. One strip will effectively fumigate 1000 cubuc feet - say 30 M^3. A quarter of a strip is enough for a bag. Anything as toxic as this to an insect is very harmful to humans. Handle the strips with rubber gloves in a fume hood or outside. One week will penetrate and fumigate the most dense object. Para-dichloro Benzene (PDB) and Napthalene are two tried and true insect repellant/insecticides. In closed bags they will kill the adults and larvae, not the eggs, so that at least a month's bagging should be allowed. These crystals may be scattered freely amongst textiles and furs to repell insects in cases and storage areas. Prolonged breathing of the vapours is dangerous. It is a good idea to use P.D.B. one year and napthalene the next so that the insects do not have time to build up immunity to one or the other.

The Bug Box

This can be constructed quite cheaply by any handyman. It is most useful to have in any museum especially if mounted on castors. It is a box which is made air-tight and uses Dichlorovos, P.D.B. or Napthalene as the fumigant. It's advantage over bagging is that you know it is not and cannot be punctured.

Spray Cans

These are merely a very, very expensive method of fogging. They will kill only those bugs directly hit by the spray. It is quite a good idea to have a can around for emergencies to give you time to rig up the fogger or if you want to chase a clothes moth.

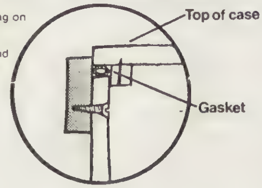
Dry Cleaning

Very few garments in a museum will stand dry cleaning because they are either too fragile or they have attachments which would be damaged by the process no matter how carefully it was carried out. However it is well to note that the larvae of the clothes moth cannot live on Keratin alone. It is the staple of their diet but they also need some sugars and proteins which are normally found in raw wool or wool soiled by food, sweat, urine, etc. If you decide that a garment can be dry cleaned then one can usually find in a town or city, one dry-cleaner who will process your artifact by hand taking all the precautions you impose upon him.

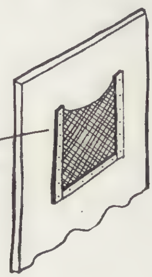
To effectively protect and invigilate your collections, you must understand something about the insects with which you have to cope; particularly their life cycles. It has been most succinctly written by

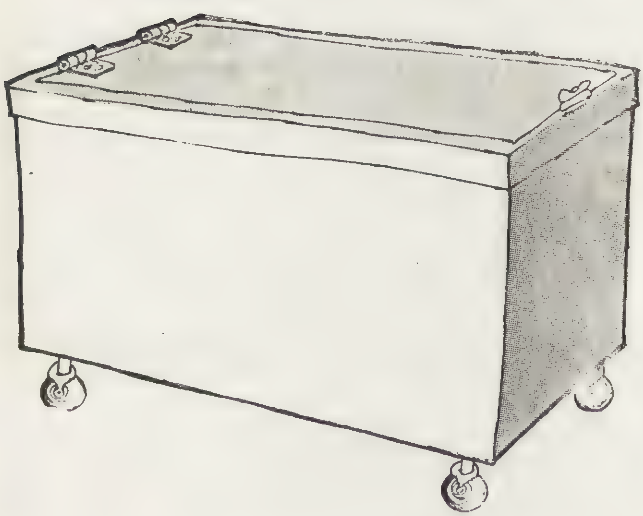
FIGURE 11 **DETAILS OF A TYPE OF FUMIGATION BOX**

Detail showing lid resting on gasket of rubber tubing glued into position. The pressure of the closed lid on the tubing makes an effective seal



Detail of envelope for crystals. Rather than spread the PDB or naphthalene crystals directly onto the material being treated place them in a fine mesh envelope of either fibre glass or fabric, attached to the underside of the lid and kept in position with slats as shown





The complete box
- dimensions optional (this one is 30"x24"x21")
- built of 5/8" plywood
- lap-jointed
- the lid hinged and secured with a simple sash lock
- fitted with castors for easy mobility

The Fumigation Box

A most useful aid to pest control is a simple Fumigation Box illustrated here. It is merely a strong airtight box in which infested material may be enclosed with either P.D.B. or naphthalene, and which can be built at little cost by any handyman. In the absence of a Fumigation Box, smaller infested objects may be sealed in polyethylene bags with a handful of P.D.B. or naphthalene.

Mr. P.R. Ward in his Museum Manual, "Getting The Bugs Out" published by the British Columbia Provincial Museum:

The Vulnerable Phase

"The life cycles of the insect pests which concern us consist of four phases: egg, larva, pupa and adult. Of these, the eggs are more or less immune to both fumigation and insecticides. Therefore, our pest control treatment must be designed to attack the insects when they are active, as larvae and adults, or when they are dormant but still vulnerable, as pupae. The weakness of all treatments,* except dry cleaning, is that they will not kill eggs. These will always be present in an established infestation and may survive to produce more insects. If we can ensure that there are no eggs present when we treat the infestation, all the insects will be killed, and the infestation will be at an end. This can only be achieved by fumigating or fogging twice, with the right interval between treatments, and by maintaining the right temperature throughout.

The duration of each phase in an insect's life is extremely variable, and is governed by several factors. Of these, temperature is by far the most important. The more suitable the conditions, the more rapidly the insect will complete each phase of its life, and the shorter will be a complete life cycle. If other facts are favourable, both the clothes moths and the carpet beetles will achieve their most rapid development at about 25°C. Therefore, if we can maintain the infested material at this temperature during and after a fumigation or other insecticidal treatment, we can control the duration of the incubation of any eggs which may have survived the first treatment. When this period has expired, all the eggs will have hatched and the survivors will be vulnerable to a second treatment. This is called the Vulnerable Phase. It ends when the first of the surviving insects reaches breeding maturity and becomes capable of producing more eggs. The Vulnerable Phase for the major insect pests are given in the chart on page 17. Only larvae and pupa will be present during the Vulnerable Phase and a second fogging or fumigation during that period should totally eliminate them. If a fumigation chamber or a fumigation box is used, the same result will be obtained by continuing the first treatment into the Vulnerable Phase.

The Vulnerable Phase of museum insect pests vary greatly but when the animals are maintained at the prescribed temperature, their Vulnerable Phase will coincide

* Except Methyl Bromide, Vikane, Ethylene Dioxide

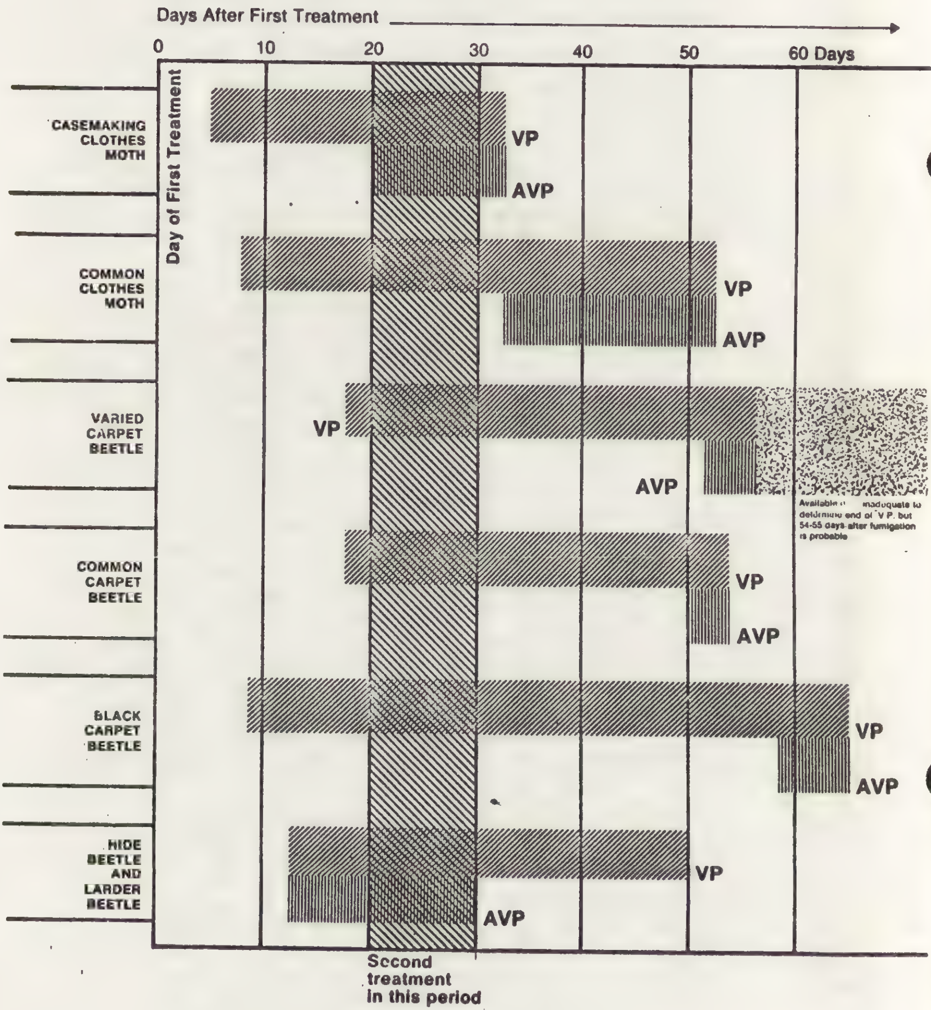
during a critical ten-day period. This is important because multiple infestations by two or more species at the same time are quite common. On the Pacific Coast many objects are simultaneously infested by clothes moths and carpet beetles which would be difficult to eradicate if each had to be dealt with separately.

If the infested material is maintained at a temperature of 25°C before the first treatment until after the second, a second fogging or fumigation between 20 and 30 days after the first should kill all the insects. As always, however, there is a catch. The larvae of several museum pests seek sheltered places in which to pupate and may burrow into impervious materials which protect them against anything but fumigation with a poisonous gas. Varied Carpet Beetle larvae will burrow into horn or balleen; Larder Beetles and Hide Beetles sometimes burrow into wood, cork or fibre board; and Clothes Moths will hide in the most inaccessible corners of trunks and furniture. In such cases fogging or spraying may be ineffective because only insects which are actually touched by the insecticide will be killed.

Therefore all material to be treated must be carefully examined and so arranged that the insecticide reaches any corners which may conceal pupae. Check the seams of clothing, open trunks and cupboards and the tops of pianos, remove drawers, and search horn and baleen for carpet-beetle holes. If you suspect that pupae may be protected in corners or holes which are completely inaccessible, the problem becomes more difficult but is still not insoluble. The concealed insects will emerge eventually, and will then be vulnerable again, but this period will only coincide with part of the Vulnerable Phase calculated for the species. This period, during which even those insects which might have escaped a fumigation by pupating in a protected place, become vulnerable, is called the "Absolute Vulnerable Phase". Since this does not coincide between species, it will then be necessary to identify the species involved, and to treat the material again during the appropriate "Absolute Vulnerable Phase".

This situation does not often arise, but in case it does, the Absolute Vulnerable Phase for the major and occasional pests are shown on the chart on page .

THE VULNERABLE (VP) & ABSOLUTE VULNERABLE PHASES (AVP) IN MUSEUM PESTS



Your Protection Plan

Everyone in the Museum, janitors, security guards up to the director, should be aware of the damage pests can do. They should all report rats, mice, and any insect seen flying or crawling around. If they can catch one so much the better but even just being alerted is something. Regular inspections are better than nothing but they have the disadvantage of turning peoples minds off between inspections. Every curator and every technician should be aware, and sub-consciously looking for, evidence of infestation at all times.

This, plus your holding room and your policy of "nothing in without fumigation" should ensure that insect damage is eliminated from your museum.

APPENDIX I

METHYL BROMIDE ATMOSPHERIC FUMIGATION CHAMBER CONSTRUCTION AND OPERATION *

by J.E. King

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The control of insects by means of fumigation has increased steadily in the last few years particularly since the introduction of methyl bromide gas. This has led to numerous inquiries concerning the construction of approved atmospheric fumigation chambers. The following information has been assembled in order to outline possible methods of constructing such chambers. Various suggestions are made which are based on experience and are meant to serve as guides. These may be adapted to the construction of chambers to meet particular problems and circumstances.

An atmospheric fumigation chamber is a gas-tight room with a suitable door and a minimum of equipment, including an applicator, an exhaust blower, and a fan. These latter two may be combined in the one unit. All chambers should be equipped with some means of fan or blower circulation in order to provide even gas distribution. A heating system should be installed if fumigation is to be done during the winter.

Methyl bromide is a colourless, odourless, volatile liquid with a specific gravity of 1.732 at 0°C., and a boiling point of 38.5°F. At ordinary temperatures it is a gas approximately 3.3 times as heavy as air. It is highly penetrative and toxic. It is soluble in most common organic solvents but is only slightly soluble in water. It is absolutely non-inflammable under ordinary conditions of fumigation. It may be procured as a liquid under pressure in 10 to 375 pound cylinders, 1 pound tins and 20 cc. glass ampules.

The construction suggested here has been designed primarily for methyl bromide gas. In designing and constructing the above facts should always be kept in mind and special precautions taken to have a completely gas-tight chamber. If the chamber is satosfactory for methyl bromide, it may be used for all other fumigants.

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Location of Chamber

The fumigation chamber may be built in a separate building or inside another building. A separate building can be ventilated more readily and there is little danger of the fumigating gas spreading into others parts of a building in which people may be working. However, if the fumigation room is constructed inside another building, the cost may be reduced as one or two walls, the floor and the ceiling could serve as part of the proposed chamber. In this case added precautionary measures would have to be followed to ensure the safety of other personnel working in the same building.

Construction of Walls, Floors, and Roof

A. Walls
1. May be of concrete, brick or concrete blocks, coated with a hard finishing cement.
2. Ordinary wood walls with plywood or sheet metal lining. A layer of roofing paper should be placed between the outer wall and lining. All joints should be sealed with an asphaltum cement or flashing compound.
3. Two layers of hardwood or laminated tongue and groove with a layer of roofing paper between. Each layer should be placed diagonally. All joints on both layers should be sealed with asphaltum cement.

B. Floors
1. A concrete floor would be the most practical. Reinforced concrete will depend on the weight of commodities to be treated.
2. Two layers of hardwood or laminated tongue and groove with a layer of roofing between. Each layer should be placed diagonally, the inner being lengthwise. All joints on both layers should be sealed with asphaltum cement.

C. Roof
1. Same as walls, should be waterproofed.
2. If chamber is inside another building, roof of present building could serve.

D. Remarks

After finishing cement or asphaltum cement has dried the complete inside, walls, floor and ceiling should be sized, followed by (3) three coats of asphaltum paint. It would then be desirable to finish with (2) two coats of a lighter paint for the sake of appearance.

Construction of Door

Door construction is of utmost importance. The success of

all treatments depend largely on their construction. They should be light in weight, easy to handle and above all tight-fitting. These points should be always borne in mind when designing and constructing.

The type of door will depend largely on the size of the chamber and the commodities to be treated. Lift doors are very practical in that they are completely out of the way when open. Sliding doors are recommended for large chambers. In some instances chambers may be equipped with two doors one at each end. These could be of either type. This characteristic will depend largely on the siae of the chamber, the commodities treated, the space available and the frequency of use.

Main part of doors to consist of two layers of hardwood or laminated tongue and groove with a layer of roofing paper between. Each layer should be placed diagonally. All joints on both layers should be sealed with asphaltum cement. The frame may be of wood of metal.

Doors must be equipped with tight-fitting rubber gaskets, preferably sponge rubber. Particular attention given to the junction of the strips. They should be bevelled to overlap and sealed with rubber cement.

All doors should be equipped with padlocks as a precautionary measure.

A. Sliding Doors

Similar to Fig. 2, clamps on sides and bottom to ensure perfect seal when closed.

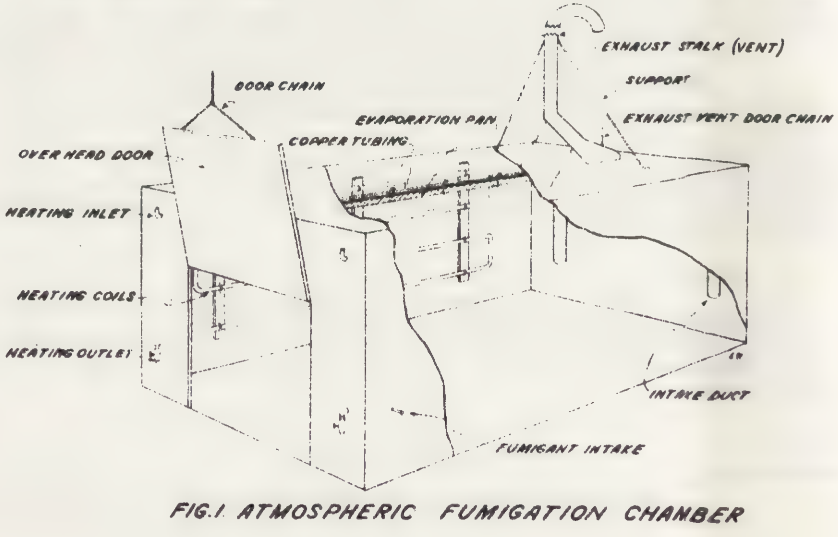
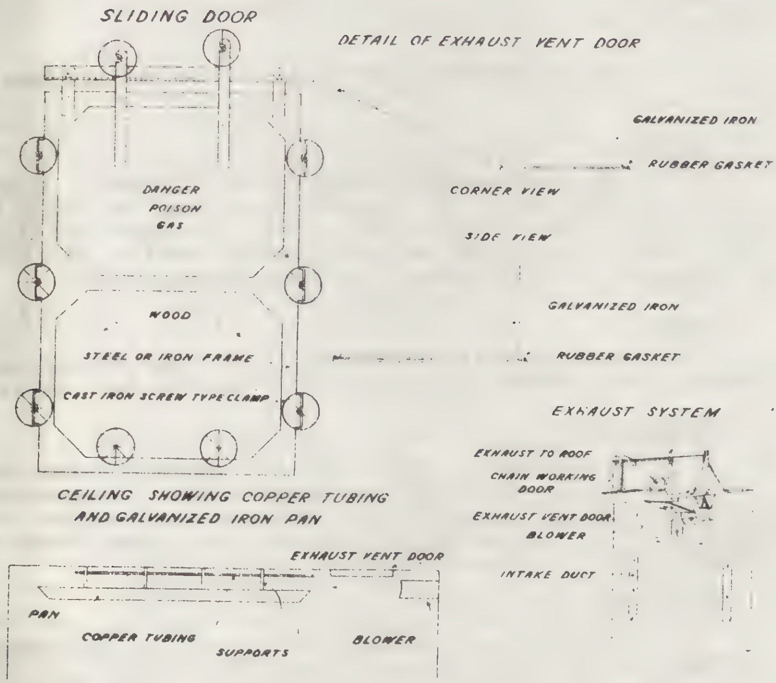


FIG.1 ATMOSPHERIC FUMIGATION CHAMBER



B. Overhead Doors

Overhead monotype doors, Fig. 1, with clamps on sides and bottom, operated by a counter weight. Gleokler refrigeration door fasteners are suitable, if available.

C. Refrigeration Doors

Refrigeration doors may be used especially with smaller chambers. As this type has a wide distribution it will not be necessary to enlarge on its construction.

Circulation and Ventilation

Fan circulation is required for the first 15 to 30 minutes of the exposure period to produce even distribution of the fumigant within the chamber. During this period the fumigant mixes with the air in the chamber forming a gas-air mixture which remains in this condition

throughout the entire treatment.

The circulation and ventilation system outlined here consists of:

1. Blowers

Size of blower will depend on size of chamber. In calculating motor size consider the cubic foot displacement per minute required, static pressure and revolutions per minute. For example: to displace 1500 cubic feet per minute the static pressure would be 5/8", motor required would be 3/4 H.P. having 1150 revolutions per minute.

2. Ducts

Ducts should be of galvanized iron. Duct diameter will depend on size of chamber and is generally 3" per 1000 cubic feet of space.

3. Inside Ducts

Intake ducts to run up back wall commencing 3 feet from floor and following side walls to join blower on ceiling. If chamber is equipped with two doors, ducts should follow door frame. Vertical part of intake ducts should be protected by diagnonal screening. Blower should be fixed to roof center flush with back wall.

4. Exhaust Door

Exhaust door should be placed in roof just above blower so that when open it will be directly in front of blower exhaust. Sides of door should be built up with galvanized iron in order to catch exhaust (Fig. 2). A chain connected (via the roof) to the side of the chamber for opening and closing. It will be essential that this door closes so as to make an absolutely gas-tight connection during the fumigation period.

5. Outside Vent

Exhaust vent on roof should be 6' high.

Heating System

If required, a heating system may be installed. There are several types available but a low pressure steam system is advised. Steam will provide higher and faster heating. Coils of 1.1/2" standard steel pipe should be placed on each side wall. All joints should be welded and controlling valves placed outside the chamber.

Gas Application

If possible fumigant should be introduced from outside the building through tube in wall of chamber either from cylinder, cans op-

erated by Jiffy Applicator, or other means. Gas is applied through copper tubing 1/4" I.D., 5/16" O.D., entering wall four feet from floor level. Tubing 2" from wall should be fitted with a flare nut 5/16" to 3/8". A sheet valve 3/8" is then connected to this nut and capped (3/8" cap with gasket) when not in use. This part of the tubing is all enclosed in a switch box 8" x 8" x 8" which may be fixed to outside wall and locked when not in use. In connecting cylinder to valve use a copper tube 1/4" I.D., 5/16" to 3/8" flare nut and at the cylinder end an adaptor 3/8" to 3/4". This length of copper tubing may be stored with the cylinder when not in use. In the chamber copper tubing should run along roof directly in line of blower. Holes 3/64" staggered every 6", should be made.

A shallow galvanized iron evaporating pan, one foot longer than tubing, at least 4" wide and 3" deep should be suspended immediately below to catch unvolatilized liquid.

Accessories

Various accessories such as fumigant analysis tubes, port light, electric connections, etc., may be added. If such are included make sure all connections are sealed properly and made air-tight.

Caution

Methyl bromide is highly toxic and should be handled only by those familiar with the necessary precautions. The manufacturers of this fumigant have outlined specific precautionary measures to be followed by persons handling this gas. It is strongly recommended that all persons undertaking treatments with methyl bromide avail themselves of this information.

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English, L.L. and G.F. Turnispeed. Chamber for Fumigating Plants with Methyl Bromide, Construction and Operation. Agricultural Experimental Station of the Alabama Polytechnic Institute. Circ. 93. June 1946.

United States Department of Agriculture. Methyl Bromide Fumigation. Pub. E-601. September 1943.

This same basic chamber may be used for Ethylene Oxide in Carbon dioxide fumigation. In this case a trough and heating pipes are not necessary. All that is needed can be bought from the supplier of the gas. (A weigh scale, control valves, support for the cylinder.)

APPENDIX II

A SMALL CHAMBER FOR FUMIGATION OF MUSEUM COLLECTIONS*

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London, Ontario

The small wooden chamber described here was designed as the result of numerous enquiries concerning the fumigation for pest control of insect, botanical, animal or other collections. It has a capapcity of 24 cubic feet/680 litres/. The safe operation of this chamber depends on the satisfactory elimination of the fumigant vapours before the door is opened at the end of each treatment. For this purpose the chamber could be kept in a hood if conveniently available, or attached to an exhaust pipe or vent running to the outside wall or to the roof of a building, from which it should protrude at least three feet into the open air. This vent should not be nearer than 15 feet from an open window or skylight which may permit the exhaust vapours to diffuse back into occupied rooms. The vent could also pass through a window which is kept closed. A vertical roof vent should be protected by a vent cap. The amounts of fumigant needed for this type of treatment are very small and, as explained below under "Precautions in the use of fumigants", the exhausted vapours will be rapidly diluted in air to minute and insignificant concentrations.

The chamber is intended primarily for use with methyl bromide, but could be adapted for use with other fumigants.

Construction

The chamber (Figs. 1 and 2) is constructed of 3/4" waterproof birth plywood, sealed and reinforced with 1.3/8" cove moulding. All joints should be carefully fitted and sealed with a waterproof glue. Brass screws are placed at all joints (including face of cove moulding) at 3 inch intervals to make a rigid shell.

Three pieces of 2" x 2" fastened to the underside of the chamber will hold it off the bench or table used as a base, and facilitate moving it.

Front section: -- The front section of the chamber has a solid face made from one piece of 3/4" plywood, by cutting out a centre piece to the dimensions of the entrance. Two locating pins are fitted, one in each side of the front section between the strips of rubber, to hold the door in

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position. Hinged bolts are placed at intervals to engage the wing nuts used for tightening the door.

The rubber moulding is fastened to the Front Section with a good adhesive cement, and may be cut during installation as long as all joints are carefully sealed with the adhesive.

Door: -- The door is also made of 3/4" plywood and holes are drilled in either side to fit the locating pins. The door holds the slotted tabs on which the wing nuts from the front section are tightened when the door is closed.

"D" handles can be fitted to the face of the door to aid in handling.

Ampoule Crusher: -- The ampoule crusher is used for discharging the fumigant. It is illustrated in Fig. 3. This particular crusher is of the size to take a 10 ml ampoule used to hold the 0 ml of methyl bromide: recommended for the present purpose 6 ml of fumigant discharged in this size chamber is approximately equivalent to 1lb. of methyl bromide per 1000 cu. ft.

The ampoule is placed in the special wire cage illustrated before it is let into the shaft of the breaker.

The preparation of ampoules of methyl bromide is discussed below under "Ampoules".

Circulation System: -- For ensuring even distribution of the fumigant after it is discharged the chamber is filled with a recirculating centrifuge type fan and galvanized iron ducts. By means of the duct illustrated in Fig. 1 the current of air is directed over the base of the ampoule crusher to circulate the fumigant as it is discharged.

Exhaust System: -- The duct from the exhaust fan is connected directly to the chamber top. If a threaded metal pipe is used from this point on a 2 inch floor flange is mounted above the chamber to connect with the gate valve. If a copper pipe is used for the intake and exhaust train a 2 inch companion flange should be fastened to the chamber instead of the floor flanges used for the threaded pipe. Whatever material is used, the exhaust pipe should extend through flanges flush with the inner surface of the chamber and any space around the surface of the pipe filled with caulking compound.

Equipment and Material

Fans: -- The two fans in this chamber should be operated by good quality shaded pole AC micro-meters. The following types are suggested for each purpose: --

A. Exhaust Fan -- Two pole continuous duty motor with 2" flange mounting on outlet and screen inlet on blower. 60 cycle, 115 volts, .70 amps, 3050 rpm.

B. Recirculation Fan -- Four pole continuous duty motor with 2" flange mounting on outlet and screen inlet or blower: 60 cycle, 115 volts, .38 amps, 1600 rpm.

Electrical: -- A. Vapour proof electrical switch box with outlets as shown in Fig. 2.
B. Cover for switch box
C. Two toggle switches
D. Gas and vapour proof 3:4" connector, straight male thread
E. Cab tire cable, 16:4 Type S.O.D. 490 inches
F. Cable as required for electrical supply to chamber.

Paint:-- lqt. anti-corrosive primer with 100 per cent Bakelite Resin
lpt. thinner
lqt. clear varnish
(One application of primer and two of clear coat varnish to interior of chamber).

Wood: -- 2 sheets, 4' x 9' and 4' x 12'
3/4" Birch waterproof plywood sanded both sides
2" x 2" Cedar for base
36' 1.3/8" Cove moulding
2" x 1" to make duckboarding or grid if trays to be set on floor level
Material for fitting sliding shelves, as necessary
Front of Chamber to be made from one piece of 3/4" plywood, cutting out centre piece.

Hardware: -- Brass screw nails (No. 8 1.1/2")
4 feet of 1" x 1/4" aluminum bar - 4" lengths
24 1/4" x 1.1/4" bolts, nuts and washers
12 3/8" Cabinet fasteners
12 3/8" wing nuts and washers for fasteners
6 inches 3/8" Brass or steel rod)
2 3/8" nuts standard and washers)
2 3/8" nuts thin (lock))
For two dowels on front to center and hold door in place for clamping.
2 2" floor flanges, steel or cast
2" pipe, copper or galvanised steel
2 2" Companion flanges if copper pipe is used

Miscellaneous: -- Waterproof Glue
24 feet 1/2" x 1/2" sponge rubber gasket
small tube or can of cement

Fumigation equipment:-- 1. Ampoule crusher specially constructed as in Fig. 3

2. One Halide leak detector with dispensable cylinder of propane fuel (obtainable at refrigeration stores)
3. Supply of glass ampoules each containing 6 ml of methyl bromid.

Preparation of ampoules:-- The filling and sealing of ampoules should only be undertaken by persons fully familiar with laboratory techniques for handling toxic chemicals. ALL WORK MUST BE DONE UNDER A PROPER LABORATORY HOOD. The Halide Leak Detector described below should be kept burning while the work is being done and used to make periodic tests to insure that the operator is not exposed to concentrations detectable by this device.

Standard 10 ml ampoules are placed neck upwards with the bodies embedded in dry ice. Standard 20 ml ampoules, available commercially, are also placed in dry ice for one hour. After this the tops of the 20 ml ampoules are carefully broken and the contents divided equally among three of the 10 ml ampoules by pouring the liquid through a glass micro funnel. In this way as many small ampoules, each containing approximately 6 ml, may be prepared as required.

Seal the tops of the ampoules carefully with a flame. The level of liquid in each ampoule is marked and the collection kept under the hood for a week for a check of leakage. All ampoules showing perceptible leaks should then be destroyed.

Methyl bromide may also be discharged from a commercial pressurized cylinder under a hood by bleeding the liquid very slowly into a graduate standing in dry ice. The small amount of gas which evaporates will help to cool the liquid. The liquid may then be poured into the small ampoules as described above.

Operation of Chamber

Material Fumigated: -- All material loaded into this chamber should be arranged or stacked so that the fumigant may penetrate effectively. Museum or collection boxes should have their covers lifted so that a crack or air space is allowed for diffusion in and out. Some preliminary observations should be made of the effect of the air movements, caused by circulating and exhaust fans, on delicate material such as the wings of insects.

In some instances it might be advisable to leave the lids of boxes only slightly opened.

Experiments at this Institute on pinned insects showed that the colouration of specimens of Odonata, Orthoptera, Hamiptera, Neuroptera, Lepidoptera, Diptera, Hymenoptera and Coleoptera was not affected by the fumigation with methyl bromide at the dose and exposure recommended.

<u>Operation</u>: -- 1. Load the chamber. Allow space all around the load to permit good circulation of the fumigant air mixture.

2. Place door in position and clamp down tightly on gaskets (make sure exhaust and inlet valves are closed).

3. Drop ampoule into shaft and insert threaded crusher. Screw crusher down until ampoule is broken.

4. Turn on circulation fan and run for 15 minutes.

5. Check with Halide Leak Detector for leaks around door and other parts of chamber (this procedure may not be necessary every time; once the chamber is shown not to leak under routine operating conditions, checks should then be made only once a week).

6. Leave chamber under fumigation for required period. (An overnight fumigation in this chamber for 24 cu. ft. from 4.00 pm to 9.00 am with the 6 ml ampoule of methyl bromide is equivalent[1] to a concentration x time product of 272 mg/l x hours, which at temperatures above 20°C 68°F should be completely toxic to any known species of museum infesting insect.)

7. At conclusion of fumigation start exhaust fan and open inlet valve gradually.

8. After 5 minutes slowly loosen nuts on door so that a narrow crack allows a current of air to flow around the door.

9. After 3 minutes loose door and check inside of chamber

---

[1] This c x t (concentration x time product) for methyl bromide is calculated as follows:

Specific gravity of methyl bromide is 1.73 therefore 6 ml weighs 10.4 g; in 680 lites (24 cu.ft.) is $\frac{10.4 \times 1000}{680}$ = 15.3 milligrams per litre = 16 mg/l approx. of 1lb. per 1000 cu.ft.

The C X T product is 16 x 17 = 272 mg/l x hours

For all practical purposes milligrams per litre is the same as ounces per 1000 cu.ft. For the derivation of this relationship see Monro (1961 p.21, footnote).

10. Keep exhaust fan running until chamber is unloaded.

11. Turn off exhaust fan.

12. Remove broken pieces of ampoule to prepare crusher for next treatment.

Precautions with Methyl Bromide

As stated above, the amount of methyl bromide in a 6 ml ampoule present no toxicological hazard if the above directions are followed. This amount of fumigant if accidentally introduced into a 20' x 20' x 10' room (4000 cu.ft.) would represent initially the concentration of 1/12 ounce per 1000 cu.ft. = 0.83 mg/l = 20 parts per million, which is the allowable concentration for continuous 8 hour daily exposure (American Conference Government Industrial Hygienists, 1963).

Methyl bromide is odourless to most people.

Careful checks should always be made with the Halide Leak Detector to ensure that the chamber is not leaking during actual fumigation treatments and that it is properly aerated during post-fumigation ventilation.

Approximate colour reactions of the Halide Leak Detector lamp using propane as the fuel is as follows (owing to variations in the response of individual lamps readings below 30 PPM are unreliable): --

Concentrations of Methyl Bromide in Air p.p.m.	Reaction of Flame
0	No reaction
10	Very faint green tinge at edge of flame
20	Light green edge to flame
30	Light green flame
100	Moderate green
200	Intense green, blue at edge
500	Blue green
1000	Intense blue

No person should remain in an atmosphere which shows a positive green or blue reaction in the flame (above 30 PPM in the above table).

Skin contact: -- In contact with the skin liquid methyl bromide may cause severe blistering. If the liquid is accidentally spilled on the skin the affected part should be washed immediately with soap and water. Contaminated clothing or shoes should be removed immediately.

Emergency case: -- There is no need for exposure of individuals to appreciable concentrations of methyl bromide in proper fumigation procedures. Should such exposure occur the following symptoms may indicate methyl bromide poisoning.

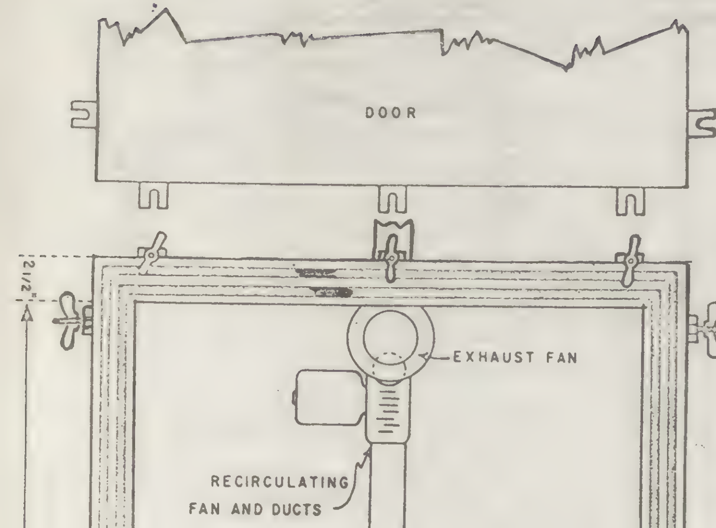
1. Nausea
2. Dizziness
3. Loss of appetite
4. Staggering gait
5. Blurring of vision
6. Slurring of speech

At the first signs of any of these symptoms the affected person should be taken to a physician.

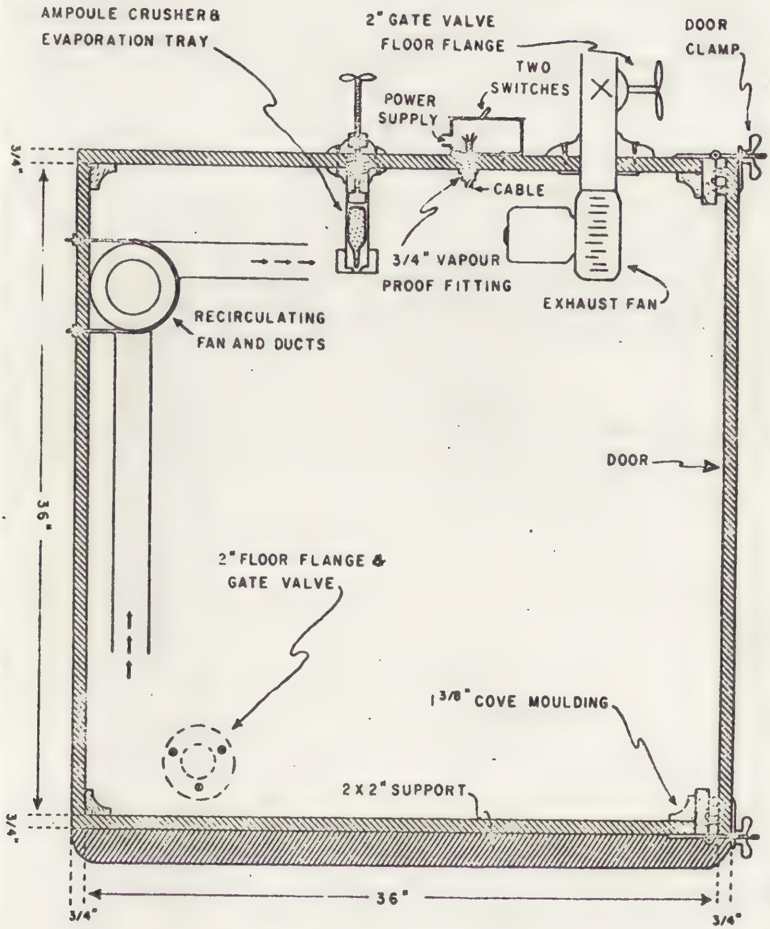
Reference

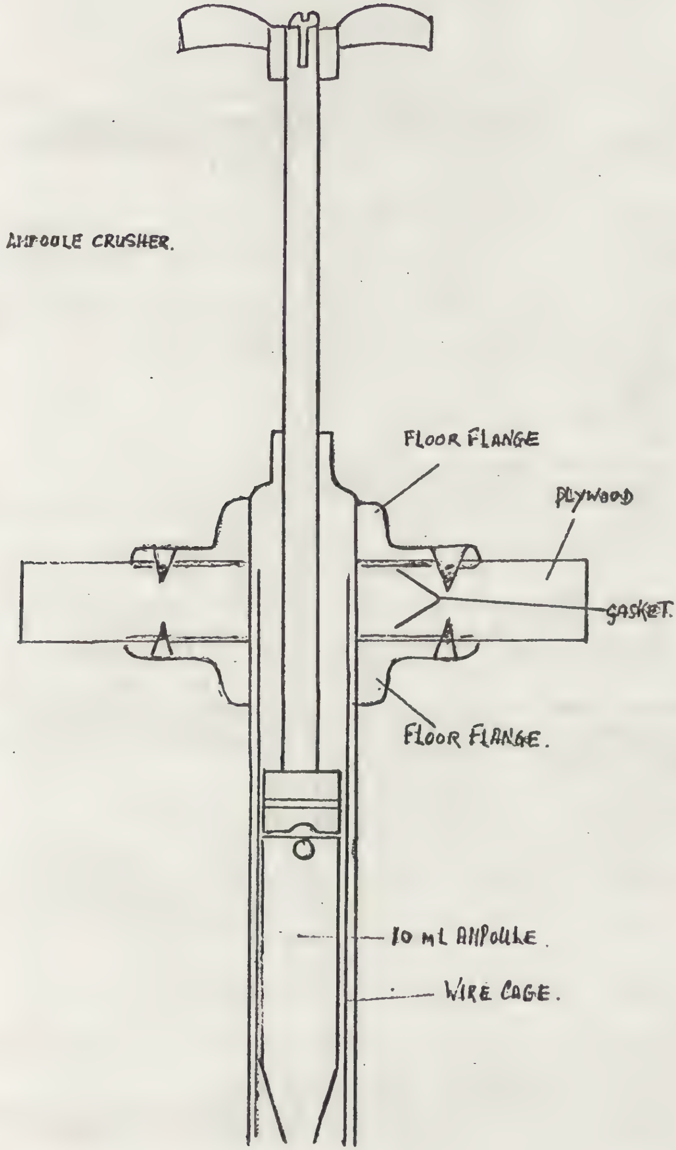
Monro, H.A.U. 1960. Manual of Fumigation for Insect Control. FAO Agricultural Studies No. 56. Rome, 289 pp.

FRONT VIEW


DOOR
EXHAUST FAN
RECIRCULATING FAN AND DUCTS
1/2" SPONGE RUBBER GASKETS
2 1/2"
32 1/2"
2 1/2"
2 1/2"
28 1/2"
2 1/2"

CROSS SECTION




AMPOULE CRUSHER.
FLOOR FLANGE
PLYWOOD
GASKET.
FLOOR FLANGE.
10 ML AMPOULE.
WIRE CAGE.

APPENDIX III

BRITISH COLUMBIA PROVINCIAL MUSEUM FILE: 18.633

PROCEDURE AND CHECKLIST FOR CHARGING FUMIGATION CHAMBERS

CHAMBER NO.:
FUMIGATION NO.:
DATE:

VOLUME OF FUMIGANT DISCHARGED:
FUMIGANT USED:
TIME:

OPERATORS: NO. 1		NO. 2	
ACTIONS: NO. 1	✓	NO. 2	✓
Unlock outer door and hook open		Inform Security Officer that chambers are to be charged and warn of alarm horn test	
Set thermostat 75°-80°F.			
Check all signals OFF			
Open chamber			
Check clamps OFF Check Pins IN			
BOTH OPERATORS MUST NOW BE IN ATTENDANCE.			
Check time remaining on mask canister and don mask		Check time remaining on mask canister and don mask	
Check clamps OFF - Pins IN		Take over check list	
TEST ALARM HORN		RESET ALARM HORN	
Enter chamber - decant fumigant Seal drum - POUR FUMIGANT		Close door (hand pressure - clamps OFF - pins IN)	
CHECK Chamber and LEAVE		OBSERVE NO. 1 AT ALL TIMES	
Remove mask - assist No. 2		Pins OUT - Clamps ON Remove mask	
Turn CHAMBER CHARGED SIGN ON		Check CHAMBER CHARGED LIGHTS ON	
DOOR WARNING ON		READ OFF and maintain check list	
CIRCULATING FAN ON			
EXHAUST FAN OFF			
CHAMBER LIGHTS OFF			
Record time use on mask canister		Record time use on mask canister	
LOCK outer door and leave		Inform Security Officer chambers charged and warning systems activated	
Signature: (No. 1) Time Completed:		Signature (No. 2) Time completed:	

NOTICE TO OPERATORS

1. The "Buddy System" applies. Always work as a team.
2. It is expressly forbidden to work alone when charging a fumigation chamber.
3. Do not depart from this procedure in any way without prior permission.

Victoria, April, 1977

Chief Conservator

78/3/1/31

APPENDIX IV

VENTING THE FUMIGATION CHAMBERS

1. The duration of fumigation must not be less than 21 days.

2. Do not vent on a still, windless day.

3. Prior to venting, inform the Duty Security Officer and check with him that no one is on the roof.

4. Start venting in the evening and continue overnight.

5. When you activate the exhaust cycle, ensure that the circulation fan is running, and observe visually the opening of the dampers in the correct sequence (the exhaust damper should open at once, and the fresh air inlet six seconds later).

6. Leave the "Chamber Charged" sign and door alarm on until venting is complete.

7. Do not, under any circumstances, allow anyone to enter the chamber until it has been vented for at least 16 hours.

8. If the fumigation has any unusual features (such as an increased dosage, a high proportion of gas-permeable materials, any open-topped containers, or anything which causes you to doubt the effectiveness of the circulation or exhaust systems), please consult Chief Conservator or his Deputy before allowing anyone access to the chamber.

9. Report any operational irregularity at once. Especially report any failure of the warning system (including lamps) to the electricians and follow through to see that they attend to it.

10. Finally, even at the risk of being unpopular, resist any persuasion to depart from these rules. In case of difficulty, refer to Chief Conservator or his Deputy.

Chief Conservator
April 1977

APPENDIX V

Equipment and Materials

I am sure there are many makes of "fogger" available but I can only recommend one I have used. The same goes for the fog itself. They are available from:

West Chemical Products Ltd
395 West 5th Avenue
Vancouver, B.C.
Canada

They have a motor driven fogger which is super-efficient which I have not used. We use the "West Spacemaster"; cost as at 1976 $95 (can) Motor 110V AC 50-60 H_3

The insecticides are:

1. "Vaposector"

    N- octyl bicycloheptane
    dicarboximide 0.50%
    technical piperonyl
    butoxide 0.50%
    (both these are boosters or synergists to the insecticide).
    Pyrethrins 0.40%
    Inert Ingredients 98.60%
    (Volatile petroleum Distillate)

2. "West Fog"

    N. octyl bicycloheptane
    dicarboximide 2.50%
    technical piperonyl
    butoxide 0.50%
    Pyrethrins 0.50%
    Inert Ingredients 96.50%

APPENDIX VI

Advice

Your Governments, both central and local, will have entomologists, perhaps working very near you. Most Biology Departments of Universities have an Entomologist on staff. They will help you identify the local bug life you must look out for.

Safety Regulations

Remember that all insecticides are toxic to humans. Get to know and understand your local health regulations. Consult your local Medical Health Officer.

APPENDIX VII

A Short Bibliography

British Museum. Clothes Moths and Carpet Beetles: Their life history, habits and control. (Natural History Publication No. 554, Economic Series 14. Trustees of the British Museum, Natural History)., London, England.

* Cornwell, P.B. Pest Control in Buildings.

Dept. of National Defense. Canadian Armed Forces Manual on Pest Control. Defense Research Board, Dept. of National Defense, Ottawa.

(A good understandable manual of techniques which deals with control methods and a wide range of insects.)

* Hickin, Norman. Household Insect Pests.

MacNay, C.G. Control of Fabric Pests. Publication 1202. Canada Dept. of Agriculture, Information Division, Ottawa.

Monro, H.A. Manual of Fumigation for Insect Control. FAO Agricultural Studies No. 56. Food and Agriculture Organization of the U.N., Via Della Terme di Caracalla, Rome, Italy.

* Monro, J.W. Pests in Stored Products.

* All the above are available from the Rentokil Library., Hutchinson & Co. (Publishers) Ltd., 3 Fitzroy Square, London W.1, England.

A REPORT ON THE TREATMENT OF MUSEUM MATERIALS MADE OF PLANT FIBRES

Arne Bakken and Kirsten Aarmo

Abstract.

This report describes the use of polyethylenglycol as a conservation agent to restore flexibility and to strengthen brittle fibres in museum objects made of plant material. Method for cleaning and repair is also described.

The Ethnographical Museum of the University of Oslo has in its collection a great variety of items made wholly or in part of plant fibres. Common for this group of materials is that low relative humidity and chemical pollution in the air as well as bad storage have caused serious damage to many items.

The fibres have become brittle, and dust and soot have made the objects very dirty. Limited space in the storage area has necessitated folding, and in many cases pressing or crushing of the brittle fibres has caused them to split or break. The shape of the objects is also often distorted.

Although objects made of plant fibres constitute a substantial part of ethnographic collections, there is little to be found in the literature about their conservation. We therefore felt the need to try to develop a more satisfactory procedure for the cleaning and conservation of such objects.

This project was started in 1972 and it was continued throughout 1973. At this point it was interrupted by the great rebuilding of our museum, but in 1978 we will resume the use of the methods we have developed on related material. The result of this we shall be glad to report in the Zagreb meetings.

Our starting point was a braided or woven mat from the islands of Samoa. It is made of the leaves of the screw-pine,

i.e. the genus of Pandanus, which comprises no less than ca. 600 varieties. Screw pines are small trees or shrubs with a crown of long, strong leaves that yield a fibre utilized for the making of many kinds of objects for every-day use.

The first step in the treatment is to clean the items. Since they are made of cellulosic material and thus similar to textile fibres, it seemed natural to adopt the washing technique used in textile conservation. The next step is to consolidate and restore the flexibility of the fibres. In the search for a conservation agent we composed a list of desirable properties which such an agent ideally should fulfil.

1. It must not have any damaging effect on the treated material.

2. Not alter the physical properties of the material in any harmful way.

3. Not change the colours of the object.

4. It should restore the flexibility of the fibres.

5. It should not prevent the movement of humidity in the the fibres.

Since it was well known to us that Polyethylenglycol had, for a long time, been used with great success on organic materials in archeological conservation, we contacted Mrs. A.M. Rosenqvist at the Museum of National Antiquities in Oslo. She suggested the use of Polyethylenglycol of the grade of 400. This is a wax which melts at room temperature and readily dissolves in water.

We found that Polyethylenglycol 400 in a 10% solution with water came closest to the specified properties and gave far the best results in our tests.

The following is a description of the treatment given the mat from Samoa. It provides a good picture both of the washing technique and the way PEG is used, so we will go into some detail here.

The mat was very dirty and was marked by wear and tear. It had several small holes and in many places the fibres were broken. On the left side there was a large hole. The shiny surface of the mat was worn off in some areas. The fibres seemed brittle and tended to break if not handled carefully. The mat had been folded during storage, and there were fold marks across it.

Before washing the mat the weak spots were covered with gauze, stitched on in order to avoid further damage. The mat was now placed in a large wash basin and made wet by means of a hand shower. It was then washed in lukewarm water to which was added enough deionized detergent to make a light foam. A sponge was pressed gently against the mat, thereby squeezing the soapy water through the fibres. This process was repeated several times before the mat was turned over and the other side given the same treatment. It was then rinsed thoroughly, the last time with distilled water.

While the mat was still in the wash basin, blotting paper was used to get out as much water as possible. A large table was covered with a plastic sheet and the mat moved into this. It stuck to the plastic sheet while wet, so that it was possible to stretch it back into shape.

At this point the 10% PEG solution was applied with a swab of cotton wool. The fibres swelled a great deal, but when the mat subsequently was dried in a stream of warm air, it came out very smooth and flat. The fringes at the edge of the mat had been especially brittle, and they were given an extra treatment with PEG.

The fibres in the mat were now much more flexible than before and some of the lustre of the fibres was restored. The holes were repaired with Japanese tissue paper glued on to the back of the mat with Columinal L 22 in a concentration of 1:10 with water. This is a watersoluble, acid-free cellulosic glue used in paper conservation. The area around each wound was dampened with water to soften the braided strips. With the aid of needle and a pair of tweezers the strips were brought back into position and fastened provisionally with a little glue. The place of repair was then turned over and Japanese tissue paper stuck firmly to the back of the mat. The whole area was covered with a layer of dry tissue paper and a piece of blotting paper. Light pressure was applied.

The covering paper was changed several times during the drying of the glue in order to prevent it from sticking. A light pressure with blotting paper in both sides was left overnight. The larger hole where some of the material was missing was strengthened with an extra piece of Japanese tissue paper. The Japanese tissue paper was coloured with a little tea to match the colour of the mat

In writing this report, it is our hope that others will be able to use the method, and that its results can be more rigorously observed and checked. In our laboratories we do not have the opportunity to do the more scientific

examination of the PEG in contact with the fibres in the treated object, such as ageing tests etc. We have, however, kept a close watch on the treated materials for several years now, and we have not found any harmful effects as yet.

The important point is that by consulting experts on three different conservation areas - archeology, textiles and paper - we hink we have found a way to treat items made of vegetable fibres that can prove useful to others.

E.R. Beecher	The Conservation of Textiles
	The Conservation of Cultural Property Unesco, Paris 1968
	Appendix: Synthetic materials used in the conservation of cultural property
A.E. Werner	Museum Journal Vol. 57 (1957) p.3
	" " Vol. 64 (1964) p.5

Personal communications:

Kari Fostervold, Textile Laboratory, The Oslo Museum of Applied Art

Nanina Løken, Paper Laboratory, National Gallery, Oslo

A.M. Rosenqvist: The Oslo University Museum of National Antiquities

CONSERVATION OF LEATHER OBJECTS IN ETHNOGRAPHIC MUSEUMS

Werner Schmitzer

Abstract:
This paper reports on methods of conservation and restoration of leather, especially dealing with the methods of dry cleaning and wet cleaning, and the lubrication after these treatments with a new emulsion which contains no wax. Investigations are described on the efficiency of these new products concerning steam porosity, air porosity and fall of pressure. Furthermore the paper reports on the restoration of wet leather finds from archaelogical sites.

The profession of a hunter and a tanner is one of the oldest of the mankind. Implements for treatment of animal skin are known already in the early history.
In the beginning of the tannery stands the tanning process with fat (grease) and with smoke. Also very early the tanning with minerals (alums) comes into use. A further development is the tanning process with vegetable extracts.
The purpose of tanning is to prevent animal skin (leather) against decaying and destruction; it presents a kind of natural conservation. By the tanning process leather is being changed in a chemical way. Therefore all applications of chemical products on old leather (e.g. for restoration) have to be done very carefully.
By the tanning process a sliding substance is being deposited between the fibres. In that way the fibres of a skin are shaked up. This guarantees the flexibility, the durability as well as the porosity for air and steam. In ethnographic collections there are many objects of leather and many objects of which leather or skin are important constituents (f.i. drums ...).
First of all a main question for a curator is: how could one take

care of objects, which are exhibited resp. stored, how could one protect them from decay.

It is very important to preserve the leather objects against drying out. Once a year leather objects should be rubbed in with acid-free leather vaseline. If one discovers that the leather begins to dissolve, it is necessary to measure the p_H; if the p_H is under 5, leather has to be neutralized. It could be done very effectively with an emulsion of the Institute for Denkmalpflege in Prague.

The cleaning of very dirty leather should also be done very carefully. There are two possibilies for cleaning: Dry- or wetcleaning.

The dry-cleaning: With a smooth brush dust and dirt are taken off. A treatment with india rubber or with special preparated cleaning clothes is very successful. If dust has penetrated very deep, wet cleaning is unavoidable. A very simple method of wet-cleaning is the treatment with a foam of a detergent (for leather furniture, -boxes and so on). In a dish with lukewarm water a detergent is put in. Then a sponge is squeezed out several times; in this way a foam is formed. This foam is applied on the leather object with the sponge. However, it must be avoided that the leather becomes too moist, especially if a wooden core is beneath the leather. Precaution is recommended for most of the detergents containing optical clearing agents. Sufficient experiences about the effects of these substances on leather have not yet been made.

After drying it is unconditionally necessary to lubricate the leather with vaseline. Therefore a fat-foam is more suitable for cleaning. I have developed products containing fats, which clean as well as care for the leather. These products are named DLM-emulsion 3070 or DLM-emulsion nr. 4060 and are suitable for all sorts of leather. These mixtures have to be emulgated under permanent agitation. However it is important that the cleaning process is carried out only with the fat-foam. Leather or parchment ought not to come in contact with the liquid. With a sponge a foam is made from this lukewarm emulsion. The foam is then applied on leather or parchment. The time of action should be only very short. Afterwards the leather is rubbed up very carefully with a dry sponge. In this way fat is taken up ba the leather during the cleaning process. After the treatment leather has a fresh and de-

licate appearance. Gold stampings are not affected by this product. For cleaning leather, products are often offered, which contain wax. It is necessary to test an unknown product on a small and not very visible part of the object which will be treated. Investigations carried out in our laboratory indicate that the addition of wax to a leather-cleaning product is of a great disadvantage. The tests were carried out with old leather (1600 a.d.) and new one. Both were treated with leather dressing-products which contain wax and such without wax admixture. The results of these investigations are described in table I, II and II and are shown in following slides. Steam-porosity, air-porosity and the fall of pressure were tested. All leather-samples which are treated with wax and fat, gave better results concerning steam-porosity, than samples which are treated only with wax.
In the last test the leather samples were thickly covered with dust. Leather which was treated with wax before gave very bad results, leather which was treated with a product containing no wax, had no dust fixing on it. Wax only has the function to give a leather-object a shining polish. It is not necessary to use wax because of the fungicide effect. One can apply a fungicide in another form.

Leather needs fat for nutriment, in order to remain flexible. However, the dosage must be very exact. Too high fat-admixture can lead to an overgreasing of the leather. All fats I use for leather-dressing are also used for the manufacturing of leather. The most of them are synthetic fats; they reduce the putrefaction resp. they stop it totally. With fat one must work very exactly, especially where the leather is connected with paper or textiles, to avoid fat-edges. Leather or parchment which becomes very hard in time, can be softened

by a Pre-treatment with "Lederweicher SR". The softening begins immediately and persists approximately one hour. The softened leather can be planned or formed in this time and the above mentioned DLM-emulsions can penetrate very well. The "Lederweicher SR" can be utilized for all sorts of leather and neither stains nor brinks remain. The softening-emulsions DLM-emulsion 1101 and 4060 can also be used.

The problem of restoration (completion) of leather: Restoration can mean: setting in missing parts, it can mean colouring, decorating and embellishing; treatments can go so far that the leather object becomes a fake. Our opinion is: the restoration should always be visible. It is important that completions or reconstructions are from the same material as the object, that is leather.

A very difficult problem are finds of wet leather, e.g. from archaeological excavations.
For the condition of such leather objects it is essential to know in which kind of soil the finds had been laying during the centuries. Leather which was found in an oxygenated soil, is in a better state than leather which was found in a moist, pebbly ground. Moisture and oxygen accelerate the degradation of tannins in the leather. Leather which got into contact with oxygen as a result of an often changing underground water-level, becomes raw-skinned. In this case one must especially take care of that leather does not get dry. Immediately after the excavation leather objects should be put into a plastic bag and quickly sent to the restoration laboratory. If leather finds completely dry up, collagen fibres are sticking together by degradation of tannins and cannot be resolved. The result is a very brittle and fragile material. In this case one comes into the situation which by the tannin could be prevented. Otherwise leather looses its form and shirinks to the half of its natural volume. By freezing the findings in a refrigerator, their drying out could be prevented. The cleaning of wet leather findings could be carried out with sodium tartate. By means of this the degradation of tannins would be prevented. With a soft brush the adhering dirt is to be removed very carefully. In water-solution one can dissolve a fungicide (e.g. TEGO 51 B). After the cleaning the remaining water is to be removed with absorptive

paper. Afterwards it must be attempted to give a nutrient in this leached leather. In our laboratory we have developed a product which makes it possible to put in fat into the leather. It is the DLM-emulsion 1101. This dissolvent (without water-content) penetrates very well into the leather and in this way the fat is dissolved in the leather. By the alcohol the leather will be dehydrated at the same time. After 4 - 5 hours the fragments are laying on a glass panel. In order to prevent a quick evaporation of the dissolvens, the fragments should be covered with a plastic foil.(They should not be pressed between two glass panels!) It is very advantageous for leather to pummel it often light-handedly. By the slow drying process of the so treated leather fragments it is very important to control these objects. If the leather gets hard again, one can lay it into the dissolvens until the desired softness is reached. After this treatment there might be a greyish layer on the leather; it can be removed very easily with alcohol.

In this moistured state the particular fragments can be sewed together. Thereby attention should be paid to the seam holes, folds and outlines of breaks. Missing pieces could be completed with adequate leather. But it is also possible to adhere the old leather fragments with a synthetic resin on a new support as you can see from the following slides.

Composition of the above mentioned emulsions:

DLM-emulsion for wet-finds and brittle dark leather Nr. 1101:

25 Tl alcohol
25 Tl toluene
50 Tl neutral fat SSS

100 ml (solution has to be well stirred up)

The container in which the object is treated must be covered, because the solvent volatilizes.

DLM fat foam-emulsion Nr. 3070:

10 % Lipoderm-Licker SA
10 % Lipoderm A
10 % Karion F
70 % water 60° C

100 ml solution with 5 % Eusapon LPK

Make a foam strongly pressing a sponge.

DLM-fat-emulsion nr. 4060 is composed similar to nr. 3070, but with 20 % Lipoderm-Licker SA and without Eusapon LPK

Hydrofilisation-emulsion (institute for Denkmalpflage, Prague):

200 ml acetic acid ester (aethyl-acetate)
50 ml Ammoniumhydroxid (25 % conc.)
250 ml acetone
50 ml lactic acid
1000 ml aqua dest.

Sources of supply:

alcohol	drugstore
Karion F (Merck, Darmstadt)	chemical store
Lederweicher SR	Fritz Minke D-4100 Duisburg 1 Postfach 527 Tel. 02131/22233
Lipoderm-Licker SA Lipoderm A Eusapon LPK	Avellis u. Huster Nachf. D-6920 Sinsheim (Elsenz) Neulandstraße 11
Neutralfett SSS	Schill & Seilacher D-7030 Böblingen Postfach Tel. 07031/1221
Toluene	drugstore

literature:

E. Merck AG Darmstadt	Chemisch-technische Untersuchungsmethoden
Stather, Fritz	Gerbereichemie und Gerbereitechnologie
Schmitzer, Werner	Alte Lederarbeiten Ihre Pflege und Erhaltung
Gnamm Dr.-Ing., Hellmut	Die Fettstoffe in der Lederindustrie

THE GLASS BEADS MAKING IN WESTERN ANATOLIA

Samim Sismanoğlu

Abstract. On the western coast of Turkey, near Smyrna there is a small village called Görece where the glass blue beads are made. Almost a century ago, two glass-makers learning this traditional East Mediteranean art in Lebanon, brought it to Western Anatolia. They have started producing glass bracelets which were not favored by the public, so they have turned to blue beads.

The broken pieces of glass gathered among rubbish are melted to glass-paste in the bowls in the furnaces heated to 700°-850°C by pine-logs. This glass-paste is taken out of the bowl by iron rods, while this iron-rod is spinned, the paste forms at the end of the rod, then it is given various forms by being pressed or rolled and the paints on beads bring out the eye forms. Once the blue beads are ready, to avoid breaking or cracking, they are left in the cooling rooms-Kavara with temparature of 100°-150°C for 15 hours.

The traditional making of this beads and decorative additions still carry the elements of Ancient Egyptian and Syrian glass making, while this primitive technology is bringing out valuable alive data in glass making.

1. Place and History.

Today, on the western coast of Turkey, Izmir (ancient name Smyrna) is an important trade center and a port. Near Izmir there is a small town called Cumaovası which has a village called Görece. Görece is 20 km away from Izmir. It is a village with 300 houses and has a population of 1200. Almost 100 out of this population are working workshops as glass-makers.

The village being in Ancient Ionian region brings out whether it is the continuation of the tradition. A small research clears this suspicion. Almost 100 years ago, two glass-masters learning their arts in Lebanon are coming to this part of the country. They started producing glass bracelets (in Arabic called Helhel) . Thus the traditional East Mediterranean glass making has moved to western Anatolia. The glass makers and their traditions had the possibility of moving from one place to another during Ottomans as they did during Romans and Byzantians. In the eastern Mediterranean jems being very

precious, decorative glass ornaments which were favored by the local people were spread around unintentionally. Especially, the makings of the glass ornaments in Palmyra in ancient times is allready known (1).

The two glass makers realizing the fact that the bracelets were not well accepted, thought of the protection desire of the local people against evil eye and thus in answer to this need blue beads are started to be made. It is a common belief among people that blue is good against evil eye. Therefore one can easily find blue beads on the harnesses, chilldren's shoulders and different places in the houses. The religious meaning of animal eyes in Ancient Egypt seems to extend through the culturs of Syria and Anatolia(2). After 1960, especially with the rising interest of tourists, not only for trinkets but for decorative elements this old art is new-born.

In the last decade few of the masters have settled in Kemalpaşa which is a small town and one master made Bodrum (in ancient age called Halicarnassus) his home carrying on their arts.

2. Bead Making.

2.1. Raw Material Acquisition.

The glass which is used to make beads is collected from the garbages as broken pieces of transparent glasses, bottles and their substitutes. The bowl which is used to melt these broken pieces into glass-paste is also broken piece of an 50-year old European Champagne bottle.

2.2. Workshop.

The workshop where the furnace takes place has no direct connection with the production and does not attribute any specialities, but the workshop must be big enough to house the furnace, logs, broken glass pieces, newly made objects and other tools. The workshop is usually made of stone-walls, covered with a primitive roof and the furnace takes place in the middle near the entrance(Fig.1).

2. 3. Furnace.

The furnace is composed of three internal sections.

2.3.1. Sur. The fire-bricks with clay and earth composition are used to make the outer walls of the inner furnace. The external surface of the furnace is plastered with clay (Fig.2).

2.3.2. Defe. When the logs are burned, the heat and flames rise to this part(Fig.2).

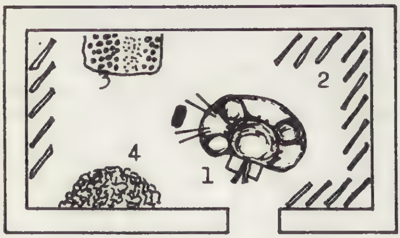


Fig.1. Plan of workshop
1. Furnace (1,70X1,10m)
2. Logs, 3. New objects
4. Broken pieces of glass

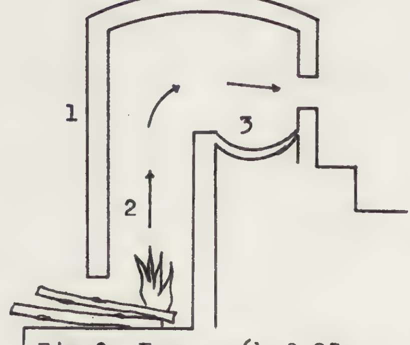


Fig.2. Furnace(h.0,95, w.0,70m), 1.Sur(wall), 2.Defe(flame place) , 3.Çanak(bowl)

2.3.3. Çanaklar (bowls). A furnace may be divided according to the number of workers who will be working around. Thus a multilateral settlement. For each worker there is a section, on the right side stay the bowls where the glass pieces are melt (always blue) and on the left side steps for colored glass (white, yellow) are placed (Fig. 3). The bowls which are of 30-35 cm diameter and 15 cm depth are made of clay. Then the pieces of European champagne bottles are melted and this paste is plastered inside the bowl and let to be cooled slowly. So it becomes like a crucible. In fact, the chemical composition of the champagne bottles has proved to be of great usefulness and does not easily become tainted during melting process of the broken glass pieces. Glass paste of 6-7 kilos may be processed in a bowl (3)

When the furnace is fully burned to 700°-850°C temperature, the pieces put into the bowl (Fig.5) becomes a glass-paste fit to be worked on. To work on the paste in the bowl of a burned oft furnace, the furnace should be heated 4 to 5 hours.

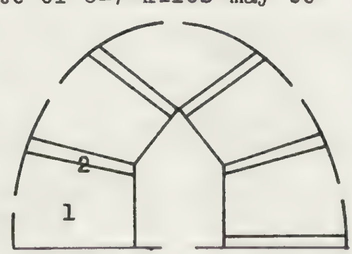


Fig.3. Traditional plan
1. Bowl, 2. Color steps

Outside of the furnace,the cooling rooms (30-35 cm high, 40-45 cm width) Kavara (in Arabic) which are made of clay and are round and doomed, take place on the right and left side of the working window which is in front of the bowl (Fig.6). These cooling rooms are connected with the inside of the furnace through a hole and therefore have 100°-150°C temperature. The beads are left in these cooling rooms to cool off for 15 hours and thus cracking or breaking is avoided and becoming transparent is successfully achieved.

Till today pine logs with some resin are preferred to be used in the furnace. Other kinds have been tried, but pine proved to be the most preferable (4). While burned it does not leave much ashes, so there is always available empty space, thus avoids the paste from becoming solid (5). Couple of logs are left on the furnace for a while to dry and avoid causing much smoke (6).

2.4. Making.

The tools used in bead making show a remarkable similarity to the traditional tools used by Middle East and Egyptian glass-making in antique ages. Since, the glass-making has come from Lebanon, the names of the tools are usually Arabic names altered by the Turkish grammer and sound harmony. The tools are made by workers themselves from iron rods and metal sheets gathered among scraps.

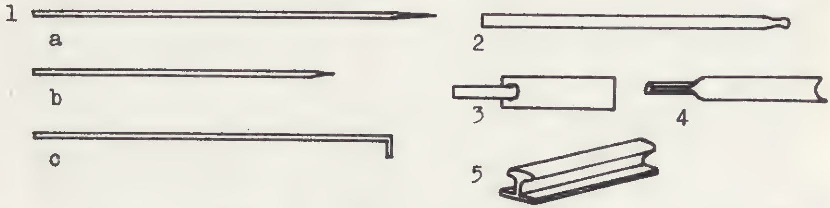


Fig.4. Tools, 1. Iron-rods, a) Asabe, b) Merdan, c) Kazaki, 2. Kecek, 3. Metleke (small shovel), 4. Kalıp (form), 5. Anvil

The furnace is burned 4-5 hours to melt the broken glass pieces to give a new form. While melting, it is stirred by an iron rod (t.2,5-3,5 cm.,1.1,20 m.) called Kecek(Arabic). Asabe(Arabic) iron-rod (t.1-1,5cm.,1.1,20m.) is thrusted through the entrance of the furnace into the glass-paste and between two hands is rolled (Fig.7),thus the paste sticks to the end of the rod (Fig.8). The rod is taken out by the left hand, put on the anvil which is in fact a rail piece, with the form-Kalıp in the right hand will be rolled to take a bead shape or with Metleke(flat small metal shovel) will be pressed to have a plaque form (Fig.9) (7).

When the bead or plaque form in blue is ready, the eye decoration is worked on.The bead-shaped paste at the end of iron rod is thrusted into the furnace and when heated is taken out. With another iron-rod (Merdan,t.8mm.,1.80cm.)in the right hand some yellow from the color step is taken and put on the bead. With Metleke (small shovel) is pressed on the anvil to merge pastes of different colors.This process is repeated with white and then with a dot of blue to form the blue-bead (Fig.10-11). All the beads and other

objects have a hole in their middle due to the iron-rod around which they are processed. During the process of the coloring of the bead, colored glasses are scattered in the color steps and are put together with Kazaki (an iron-rod with a curving end which has 90° angle and 6-7cm. length (8)). While using Kazaki it starts getting hot and colored glass-paste starts sticking to it. To avoid this, from time to time Kazaki is put into water. Besides the eye-motive, on some cylindrical beads decorations similar to it motives (trail-on) in old Egyptian sand-core glass technique can be seen (9) (Fig.13). During this making, to economize in time, the skill of coordination of two working hands is necessary (10).

Once the blue beads are ready, they are put with a small shovel in the Kavaras which are cooling rooms. Here they stay for about 15 hours to cool off and get transparent (Fig.12). There might be air bubbles in the finished beads.This is due to low temperature 700°-850°C and technical insufficiencies (11).

2.5. Types of dye and how they are achieved.

The glass masters are not aware of the chemical compositions of dyes they use. They utilize their local raw materials without knowing their specifics. Traditional methods are used,and no personal knowledge and technical additions are made. Dyes are melted with transparent pieces of broken glass and colored glass is attained.

2.5.1. Blue.

In copper workshops, copper objects after being annealed to red are dumped into water and the copperoxide powder gathers in the water. The glass makers mix this powder with salt and sawdust and burn this mixture in Kavara (cooling room) (12). Sawdust is mixed to attain even burning. As the result of burning,the mixture becomes blackish-blue. Amount of copper addition decedes the shades of blue.

2.5.2. Yellow.

For yellow dye lead, tin and zinc are used.Three measure of zinc, 6 measure of tin and 12 measure of lead are mixed in a flat crucibles called Merkebe (Arabic) while being stirred for two hours on the wood placed opening of the furnace. The amounts of different materials are not strict, rather depend on the practice of the glass maker, therefore differences may be easily seen.

2.5.3. Green.

Green dye is achieved by mixing blue and yellow

which are explained above. The amount of copper used decides the shade of the green dye.

2.5.4. White.

Bone pieces are put in a crucible-Merkebe and left to being heated for a day on the opening of the furnace where the logs are kept. When the ashes of the bones (white dust) are mixed with glass-paste, it gives a dull white color. Even though this white glass has an opaque appearence, it is achieved through a long and difficult process.

3. Types of beads.

At the beginning the blue beads were made in shape and volume to fit where they were going to be used. Today, due to the demand created by the tourists, they are made to be used on decorative objects (bracelets,neklaces) . Besides blue beads, plaques are used for decoration . According to their shapes beads are named, 1)Cylindirical bead (with trail-on),2) Plaque (with eye motive), 3) Doll, 4) Ashtray, 5) Heart, 6) Fish, 7) Oil-lamp, 8) Round bead, 9) Circle, 10) Ox-eye, 11) Black-eye (three sides) , 12) Rectangle, 13) Ring, 14) Walnut and ball, 15)Cylindirical bead, 16) Necklace(made of rings and flower shaped flat beads with eye motives) (Fig.13). The sizes of the objects created have been standardized according to the skills of their creators. There might be changes in size due to private demands or personal wishes.

4. Conclusion.

Thus, what is explained above brings clearly out the fact that East Mediterranean traditional folk art of glass making is still practiced in Western Anatolia. This folk art brought almost a hundred years ago passes from master through assistant master to apprentice. The glass bead makers are carrying on their profession without necessary technical knowledge. From the it has started, this art is based on traditional shape, style, technique and skill. Therefore, blue bead making in Western Anatolia carries enlightening clues to Ancient Egyptian and Syrian glass-making.

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(2) Saldern,A.v.,Nolte,B.,Baume,P.L.,Haevernick,T.E., Gläser der Antike,Sammlung Erwin Oppenländer,Mainz, 1974, p.30, fig.34-35.

Bezborodov,M.A., Chemie und Technologie der antiken und mittelalterlichen Gläser, Mainz, 1975, pp.116-117. there are some beads with eye motive at the collection of Archaeological Department of Middleasian University in Tashkent.

(3)Bezborodov,M.A.,op.cit.,p.77, fig.9.

(4)Theophilus Presbyter, Schedula diversarum artium,Lib.II, cap.I, (translated by Ilg,A.,Quellenschriften für Kunstgeschichte und Kunsttechnik des Mittelalters und der Renaissance, Osnabrück, 1970). Beechtrees have been referred.

(5)Bezborodov,M.A.,op.cit.,p.49. It is mentioned that beech trees and trees from the pine family leave less ashes in comparison to trees with leaves.

(6)Theophilus,op.cit., Lib.II, cap.XXIII.

(7)Bezborodov,M.A., op.cit. p.118, he mentions a similar method of bead making.

(8)Labino,D., "The Egyptian sand-core technique, a new interpretation", JGS, Vol. VIII (1966), p.125.

(9)Labino,D.,op.cit.,p.124.

(10)Labino,D.,op.cit.,p.125.

(11)Bezborodov,M.A., op.cit.,p.98.

(12)Hodges,H., Artifacts, London, 1965,p.45.

Fig.5. The broken pieces of glass are put into the bowl.

Fig.6. The furnace is heated.

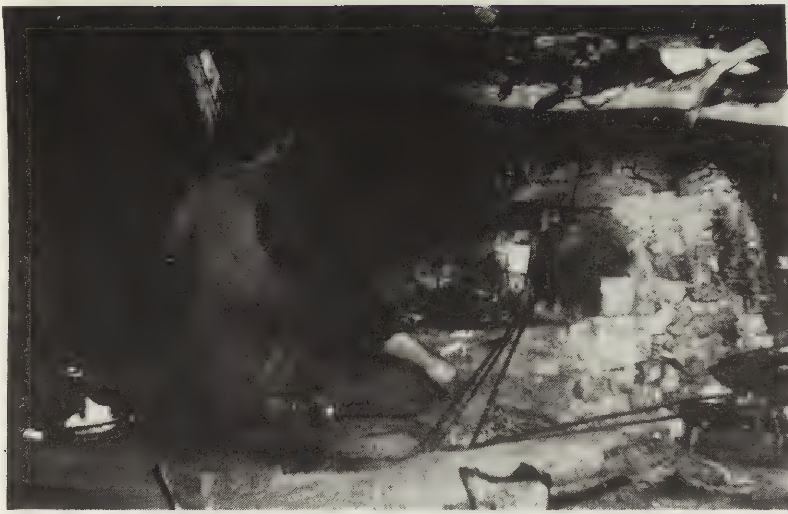


Fig.7. The glass-paste is taken out of the bowl by iron-rod.

Fig.8. The paste sticks to the end of the rod.

Fig.9. With small shovel will be pressed to have a plaque form.

Fig.10. Color is put on the bead.

Fig.11. With small shovel is pressed on the anvil to merge pastes of different colors.

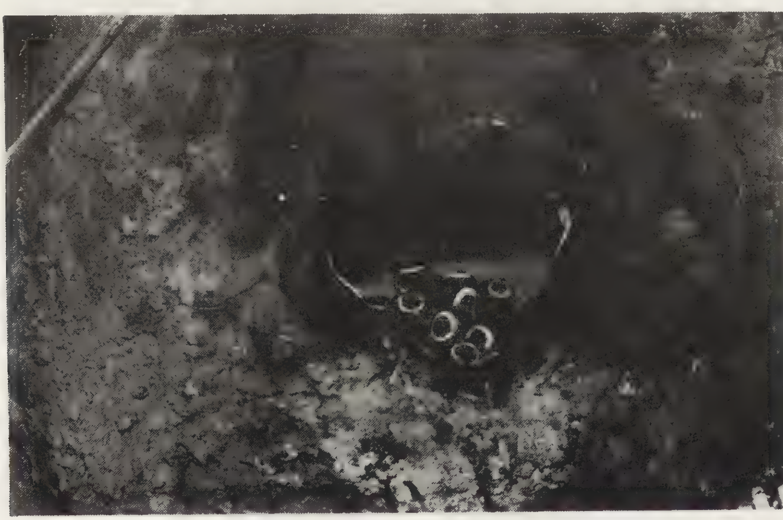


Fig.12. The cooling room.

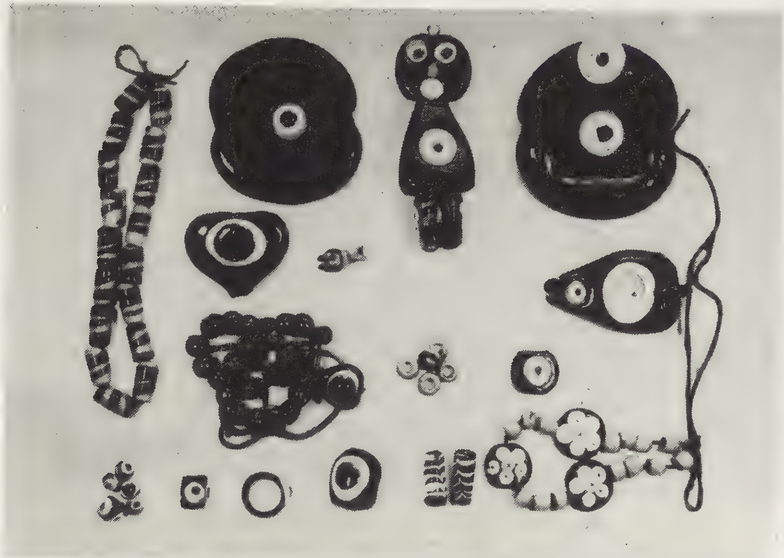


Fig.13. Types of beads.

THE RENOVATION OF A MUSEUM FROM THE POINT OF VIEW OF A RESTORER

Karl-Albert Fritsch

Introduction

The reflections, fears, impediments, failures, and also successes which a restorer has to face in the extreme situation of a complete removal and, later, reintegration of the total inventory of a medium-sized European museum, may to some of you be of secondary importance. Possibly you have just mastered a similar situation and are now happily established in a new place; in that case we could learn from your experiences and exploit them for our future work. Maybe you are absolutely certain that you will never have to cope with similar problems. If that is so, you might look upon the matter as a kind of quiz, and you might help us — and everybody else in the same situation — by checking on our decisions, or perhaps by giving valuable advice. If at the end of this lecture a discussion would develop between those affected and the lucky ones for whom these problems are only a matter of theoretical reflection, I should feel that this effort of mine has been worthwhile.

To begin with, a short survey of the contents of this lecture: Some general reflections on the situation of the restorer in the Bremen Übersee-Museum will be followed by an outline of the history of the Übersee-Museum and a description of its buildings, its workshops and store-rooms as they existed until the beginning of the first reconstruction measures. After that a look at the reconstruction plan will be absolutely necessary because only with that in mind one can get an idea of what in this particular case the shifting and re-storing of the inventory implies. Then I shall describe the difficulties arising while the objects are being shifted. And finally I shall strike the balance of our successes and failures.

The situation from the restorer's point of view: I should mention here that this report is concerned with the ethnographic section only, not with any of the other sections, such as "Natural Sciences", or "Commercial Science". The necessity to shift a museum's entire inventory from one place to another entails more responsibility for the restorer. In this connection it will be sufficient to note that in spite of the increase of work quantity which was to be expected it was not possible to increase the number of staff employed in our workshops as restorers. I shall come back to this problem later.

History of the museum; main building and "House 2"

Some of you will have a good idea of what the Übersee-Museum looks like. Either they have seen it with their own eyes, or they have read about it in publications. For those who have neither seen it nor read about it, I should like to give a short outline of its history.

The oldest part, i.e. the front-half of the building was finished in 1895. It consisted — this is typical for many European museums built at about that time — of a central hall surrounded by galleries. Its name then was "Städt. Museum für Natur-, Völker- und Handelskunde". Its collections consisted of a great variety of objects. They had come to Bremen more or less at random. Skippers, colonial officers, agents of Bremen's commercial firms had acquired them abroad and had presented them to their home-town

museum. Other objects had been collected by students of the natural sciences doing research work in foreign countries.

Professor Hugo Schauinsland, the museum's first director, succeeded in organizing and arranging this varied mixture of objects under distinct general themes. With the generous financial support of local merchants he was able to undertake jouneys and to do his own research abroad. Thus the collections were systematically built up in such a way that they came to be a documentation of the early colonial period and a presentation of new findings and discoveries in the field of the natural sciences. In this form the museum attracted many visitors from all walks of life. During the years 1907 to 1911 a second hall of equal size and equal form was added to the original building, which had become too small for the fast growing collections. That way the space available for exhibitions was doubled.

From its first beginning a characteristic feature of the museum have been its living palm-trees. This specialty will be preserved, as it is felt, that the palm-trees make a visit to the museum more enjoyable for those seeking relaxation. And museologists still feel that the aspect of relaxation should be considered in museum planning.

The museum was almost completely destroyed during World War II. Under great difficulties it was built up again and the galleries were re-done in such a way that before long the house — now under its present name "Übersee-Museum" — was attracting again large numbers of visitors. However, the technical facilities — such as energy supply, sanitary installations, heating system — were in a desolate condition and hopelessly antiquitated. Some of these installations dated back to the time when the house was first built. As the war damages had been repaired in a most inadequate way, there were repeated breakdowns of the technical facilities.

Also the building was no longer in keeping with todays safety and fire-precaution regulations. Actually thorough reconstruction was the only way out of the dilemma.

Luckily a municipal building in the immediate neighbourhood — only about 50 m away — was vacated at the time. Some red tape had to be overcome, until this house — Bremen's former State- and University Library — could be taken over by the Übersee-Museum and be used for storage, which is a great help, after all.

Condition of magazines and conservatory work so far

Before the First World War a much larger percentage of the museums's objects were displayed in the galleries, and the space required for storage was comparatively small. This was the case not only in our museum, but in many others of similar size and nature. However, after the Übersee-Museum had been damaged — this was in the Second World War — to a point that one even thought of tearing it down altogether, it was finally built up again in such a way that much of the space so far used for the permanent exhibitions, was now turned into magazines. Naturally these store-rooms were — from the conservator's point of view — most inadequate. The windows did not shut properly. The cabinets and cases in which the objects were kept, were either made of inferior material, or they were unsuitable because they had originally been made for other purposes and were now re-done in a rather make-shift way.

In the workshops, the situation was the same. Until 1945 it had been the man with a hammer, some nails, a pot of glue, and petroleum who looked after the objects. After that, efforts were made to improve the situation step by step, that is: to get more staff, and to get better equipment. And here I must say again, that until this day there has been not the slightest improvement, as far as the number of staff is concerned. Vis-à-vis about 80.000 objects, the total of four restorers is entirely out of proportion. And the fact that in other museums the situation is just as bad — sometimes even worse — is not much of a consolation. In 1945 there was practically no useful equipment, nor

material, in the workshop, so that we had to start from nought. This proved to be rather an advantage. For those so far entrusted with conservation had only a minimum of knowledge of such techniques and methods of conservation which had been developed in other workshops or laboratories. They only had their individual experience as craftsmen to rely on. So we could now start buying one by one — our financial resources permitting — such tools and materials as the newly developed techniques required. The same happened with regard to the equipment of our store-rooms. Furthermore the restorer was in a position to improve the knowledge and experience he had been acquiring on his own, by making use of every possible chance of further training, for instance by attending seminars, courses and meetings such as the one we are having here now. Under four directors we have been able to continue on this course, more or less effectively, until it was interrupted by the necessity to move all the museum's inventory in connection with the current reconstruction of the house. This was a most consequential break which will, for years to come, determine the activities of our workshops.

Plans for renovation and evacuation; realization

At this point I shall have to give you a rough idea of our renovation programme and the planned timing. This will help you to understand why the shifting of objects had to be organized the way it was done. Originally "renovation" had been meant in the sense of modernization, that is: replacement of antiquated and inadequate technical installations (toilets and washrooms, heating system, lighting) by new ones as well as the introduction of fire-precaution and safety facilities prescribed by law (fire escapes, ceilings and glass-roofs with certain constructions).

However this renovation plan offered also an opportunity to re-style parts of the museum in accordance with the new conceptions which had meanwhile been worked out for the arrangement of the new displays. There is not the time now to enlarge upon this topic although you might find it quite interesting. But this is worth noting: From the beginning of the planning phase in 1966, no decision has ever been passed without consideration of the conservatory point of view. Thus it was decided that for the more than 300 windows of the museum building stained glass be used to protect the objects displayed against the heat of the sun and against ultraviolet rays. The only arguments in favour of stained glass were conservatory considerations, and the consequences for the entire make-up of the galleries will be considerable. Now this is the architect's schedule:

a) Phase 1: Reconstruction and modernization of the rear half of the building. Rooms in the front half are temporarily turned into workshops. Part of the museum's front area still open to the public.
b) Phase 2: After the reconstruction of the rear half has been completed, the restorers move to their new workshops located in the rear of the building. Now the front half is re-styled and modernized. The whole of the building is closed to visitors.
c) September 1979: Re-opening of the museum. Part of the ground floor galleries (South Pacific; Australia; Marine Ecology) and part of the galleries on the second floor (Bremen's Economic Background; The Region of the River Weser from Bremen to the North-Sea) will be the first to open. The time of the re-opening of other galleries will depend on the money available and on the capacity of the workshops.
d) Re-building of "House 2", in which — apart from ethnographic magazines — rooms for the rest of the museum's scientific staff have to be provided.

This schedule gives an idea of the amount of work involved. For this reason one of our colleagues was especially commissioned with the planning, coordination and execution of all measures to be taken in connection with the shifting of the inventory.

staff member so far working as a cashier, is now employed as an assistant in the workshops. Efforts are being made to find someone else for the job of a "deputy shifting commissioner" so that the restorer who is now doing this job, can return to his work in the conservation workshops.

Planning of the new permanent exhibition and conservatory workshops; the final store-rooms

Quite a lot of working hours were spent with discussions about the new ideas and their realization. Apart from the head of the conservation workshops, two restorers took part in these discussions. Later, when the ideas conceived in the discussions will be put into practice — for instance by building dioramas — all the restorers will be involved. Therefore we are not sure that there will be time for the conservatory treatment of all objects selected for display in the future permanent exhibitions.

Of course every one of our restorers had his say in the planning of our new workshops. They were represented at all our conferences, since joint discussions and joint decisions, combined with joint responsibility, are being practised in our house. This, too, meant a considerable loss of time which might otherwise be used for conservatory work. On the other hand, this active participation of the restorers was the best way to ensure that the best possible use was made of the funds allocated for the equipment of the workshops.

Fortunately there was no need for the two restorers still occupied with conservatory tasks, to move to a temporary accommodation as long as the rear of the building was under reconstruction. Their workshop had always been located in the front half of the house. What turned out to be a big disadvantage, however, was the interruption of the procurement programme which stopped when the reconstruction plans were beginning to materialize. After great difficulties, the installation of a low-pressure chamber, which had been applied for about twenty years ago, was included in the reconstruction programme for the rear half of the building. Then t was put off again and made part of the reconstruction programme for "House 2" because various authorities raised objections for safety reasons. This means another six years before this project will be realized.

I have already mentioned the difficulties we had when we wanted to buy some additional air-conditioners. By the way, the purchase of "Thermo-Hygrographs" was not even taken into consideration. We hope that we shall finally be able to buy a "Faxitron" x-ray apparatus and the "Airbrasive" unit we have applied for a long time ago.

Before I close this chapter, let me say a few words about our future store-rooms. They will be air-conditioned, or, at least, be equipped with airing facilities, and the windows will also have stained glass. All ethnographic magazines will be concentrated in "House 2". The conservation workshops will be in the main building, but there will be no longer the necessity to cart the objects across the open road, from magazine to workshop. The two buildings will be connected with a tunnel.

Balance of failures and successes

Before I end I should like to strike the balance of our successes and failures. We have achieved that whenever decisions were passed involving ethnographic objects, conservatory considerations have played a decisive part. This was true for the reconstruction planning, for the execution of individual reconstruction measures, for the moving of objects, for the preparation of provisional store-rooms, and naturally also for the setup

of the future displays. Losses and damages could not altogether be avoided, but were kept within reasonable limits.

What could not be avoided was the necessity to work under pressure of time, not only with regard to the dates fixed for the various moves, but also with regard to the conservatory treatment of objects selected for future display.

Also we did not succeed in increasing the number of staff in our conservatory workshops although every opportunity was used to convince the higher authorities of the increase in work quantity caused by the repeated shiftings and re-arrangements of objects.

What could not be realized was the original plan to have "House 2" rebuilt first. The renovation of the main building would then have been the second phase, most of the objects could have been taken to their final storing places in one move only, and nearly all the extra work of repeated shiftings would have been avoided. Also, the ethnographic objects would have suffered much less. But had this much more practical and reasonable order be followed, the re-opening of the museum would have been delayed for some more years.

We succeeded in securing the best possible equipment for our workshops -- which doesn't mean the best at all --, under the given circumstances. This new equipment includes some larger apparatus we had been trying to get for many years. However, we did not succeed in getting this new equipment installed in time. In the face of the situation just described, the responsible restorer will be content if he gets away. All that matters to him is the success of his efforts to protect the objects entrusted to his care against damage, or even loss. He is determinded to continue on this course.

Summary:

The renovation of a museum necessitates the complete removal and, later, re-integration of the total inventory, i.e. not only of the objects displayed in the galleries, but also the pieces stored away in the magazines, the furniture, the machines and tools in the workshops etc. For the responsible restorer this means much extra responsibility, and a lot of extra work. While he is forced to stick to a certain time-table, he will find himself in a permanent struggle against unforeseen difficulties. For instance steps have to be taken to improve the climatic conditions in the temporary store-rooms and to avoid damage, or even total loss, when objects are being transported by unskilled workers. The objects selected for display in the future permanent exhibitions have to be treated in the workshops. New ideas conceived in lengthy discussions have to be worked out and put into practice. By far the biggest handicap is lack of time and shortage of labour.

PEST CONTROL IN ETHNOGRAPHIC MUSEUMS BY MEANS OF FUMIGATION

A. Vetter and W.P. Bauer

Abstract

More and more often valuable art objects made of wood and other organic materials are befallen by insect pests. Numerous chemical agents are available to prevent destruction of these objects by insect attack. Gaslike fumigants such as hydrogen cyanide (ZYKLON), methyl bromide (HALTOX) and ethylene oxide (ETOX, ETOXIAT) have the advantage in contrast to contact-type insecticides that they destroy not only those pests located on the surface but also those which have penetrated to the inside of the objects. Furthermore, not only the mature insect is reached but the insect at all stages of its development as well.

In the following text we shall show by means of several examples what pests attack which objects and how they can successfully be controlled by means of different fumigation methods.

Using the newly constructed vacuum fumigation chamber in the Musuem für Völkerkunde in Vienna as an example, the basic principles to be considered when installing fumigation systems in ethnological museums are given special attention.

At the same time man began to work with stone, wood and other materials, the problem of the preservation of such objects arose as they can easily be attacked and destroyed by pests. In the course of man's further development works of art - some of inestimable value - were created. It would be impossible to replace them; however, their preservation is not only conceivable but absolutely possible.

Numerous wood-destroying insect pests are known:

Insect pests:

Besides nourishment, temperature and humidity are of vital significance in the existence basis of insect pests. Within the temperatures which limit the development scope of a specific animal species lies the development optimum which necessarily leads to an increase in the population of this animal. Under these conditions great haste in combating these pests is essential. In spite of constant new developments and research in the field of chemical pest controls, insect pests are still among the most dangerous enemies of our art treasures. Of course, they are not only a menace to cultural goods but to all items made of wood or other organic material.

Initial damage to timber takes place in the forests. One of the most harmful insect pests here is the bark beetle which can be divided into two types: those which breed in the bark and those which breed in the wood. Pityogenes typographus is among the best known from the former type. In the latter group are mainly "mould breeders", i.e. those insects which are able to produce on the walls of their borings moulds which serve them as nourishment. As a result the borings turn dark and are thus easily recognizeable. A number of Xyloterus types belong to them. The patterns produced by the larval borings are pretty; however, they can reduce the value of the wood considerably.

Freshly felled conifers are often befallen by Callidium violaceum, fresh deciduous trees by Phymatodes testaceus. Usually the larvae penetrate only into the cambium, which however can be severely damaged by the resulting large holes. Conifers, even debarked, are occasionally befallen by wood wasps, among which the most important is the Urocerus Sirex gigas. Since the maturation period of the larvae is two to four years, it is possible for adults to hatch in structural wood. In exporting to Australia certification is therefore required that the packing cases are free from infection. These crates should therefore preferably be submitted to fumigation.

Not to be forgotten are the termites which are among the most harmful wood destroyers in the tropics and subtropics. In southern Europe the so-called dry-wood termites Kalotermes flavicollis and two species of moist-wood termites Reticulitermes sp. are mainly

found. Termites shun the light, that means that the wood surface remains unharmed so that the extent of the rapidly progressing damage is often only then noticed when it is already too late.

The most well known insect pest found in structural timber is the European House Borer Hylotrupes bajulus. The adults, which are 10-25 mm long and dark brown or black in colour, although not often detectable, are widely known. In the course of their maturation period of two to seven years the larvae cause great harm as they penetrate the sap wood with their borings. Only when food is scarce do they occasionally attack the heart wood. The exit hole is oval, sometimes a bit ragged, and has a diameter of about 4 x 7 mm.

Also well known and widely spread are the wood borers, among which the furniture bettle, also known as the death watch beetle Anobium is of great significance. The scientific name is Anobium punctatum de Geer. These beetles, which attack both deciduous trees and conifers, are destroyers of wooden artifacts; they appear, however, also in roof and beam constructions as well as in furniture. Development from the egg to an adult able to fly takes two to three years. In the case of this insect pest as well maturation takes place inside the wood, meaning that the damage is visible only after the first adults hatch. They leave the wood through a usually circular hole the diameter of which is 2 mm.

Worthy of mention is also the powder post beetle Lyctus brunneus which comes from tropical regions and is spreading throughout Europe. Lyctus brunneus, along with Lyctus linearus, was the first to cause extensive damage in Europe. According to one report, the powder post beetle has also become a serious problem in Israel. What is interesting in this connexion is that it was most likely imported from Asia.

Powder post beetles are carried to all parts of the world not only through trade in raw wood, e.g. elm, abachi, ramin or limba, but they are also very often found in African, Indonesian and Southeast Asian artifacts brought by collectors or private persons. Since a maturation period of more than a year must be reckoned with, the presence of these beetles often remains unnoticed for some time. As a preventive measure, newly imported art works should be fumigated in any case to hinder further spread of these harmful insect pests.

Not to be forgotten are the numerous species of carpet beetles Dermestidae which include the Dermestes lardarius, various Anthrenus sp. and the Attagenus sp. The larvae of the above beetles are the actual pests. They are found in herbariums, in entomological, ornithological and zoological collections, in ethnographics, leather articles and textiles, e.g. in old costumes, etc. Since the climatic conditions in museums and archives are generally very

favourable, several generations can develop in a year, thus causing considerable damage. Ptinus sp. and Stegobium paniceum appear often in libraries, also book lice and dust lice, which belong to the corrodentia family.

And finally we would like to mention the common clothes moth Tineola biseliella which causes serious harm to textiles.

Pest control by means of fumigation

The choice method of pest control in a museum is fumigation. In this way, one hundred per cent destruction of the insect pests in all stages of their development can be attained.

What factors must be considered in undertaking pest control in a museum with the highest degree of effectiveness possible and what means can be employed to this end are illustrated by the installation of a fumigation system in the Musuem für Völkerkunde (Ethnological Museum) in Vienna.

The Ethnological Museum had a fumigation system which was built in 1930. It consisted of three wooden troughs of different sizes, each lined with zinc. Carbon disulphide was used as a fumigant. The layout was under air pressure; the covering tended to allow leaking. As a result of these less than ideal conditions, each batch had to stay in the troughs for weeks, and still the fumigation did not entirely reach the full effect of an insecticide. Moreover, the operation of the system was dangerous for the service personnel due to their unavoidable contact with the vapours. A further drawback was the extremely unfavourable location of the layout in the cellar.

In case of emergency, i.e. escaping gases, it was not possible to ventilate efficiently as CS_2 is heavier than air. The location in the basement brought further disadvantages. Prior to fumigation, all objects coming from outside had to be unpacked from crates and then carried in small baskets through many rooms of the musuem into the cellar. Thus, the spread of any insect pests throughout the museum before fumigation and destruction was possible.

In planning the installation of a new fumigation system in which the most modern aspects were to be included, special care was to be taken in choosing the site.

In order to prevent infection of museum stock by pests, all items brought into the museum - whether from expeditions, new purchases or travelling exhibitions - must be fumigated upon arrival before they come in contact with other items. This means that the fumigation system should be installed where the objects are unloaded from transport vehicles and brought into the museum.

A sluice of this sort is located in the Ethnological Museum, Vienna, at the entrance to the carpentery and all other technical workshops. It is a side entrance to the museum accessible through a large gate for transport vehicles of all sizes coming from the Heldenplatz. The sketch below illustrates the location:

Fig. 1
Fig. 2
Fig. 3
Fig. 4

After fumigation the items are stored for several days in an adjoining room for airing. Only then (following, of course, listing in the inventory and restoration) are they incorporated in the museum stock. In planning a fumigation system, it is necessary to discover such an ideal location. In the case of old buildings this can be realized only with difficulty or merely to a limited degree or perhaps not at all. In constructing our fumigation system on the site shown, we also encountered great difficulties with the authorities concerned with the protection and conservation of cultural property; however, our arguments were able to convince them.

The new fumigation system was meant to fulfil the following conditions:

1. The fumigation process should be carried out in as short a time as possible;

2. The fumigation process should have such a permeating effect that fumigation is possible without first having to unpack the objects from their crates;

3. Fumigation should be effective as possible and at the same time include maximum safety measures;

4. The fumigant should work not only as an insecticide but also as a fungicide and, if necessary, also be effective against bacteria.

These stipulations can best be met by a fumigation system which works in a vacuum coupled with a by-pass system using as the fumigant

ethylene oxide mixed with carbon dioxide (ETOX = 90% ethylene oxide + 10% carbon dioxide).

The by-pass system

In a chamber which works under normal pressure (air pressure) the fumes penetrate only very slowly into the material to be treated. This process, which can be termed gas diffusion, can be accelerated by using a diagonal recycling of the gas/air mixture. The resulting cycle leads to a quick, intense penetration of the gas/air mixture into the objects, whereby the duration of the fumigation process can be significantly reduced. If this cycle is led through a gas-tight air heater, the contents of the chamber are warmed and the effect of the gas is increased.

This by-pass system also enables a rapid and intense airing of the materials after fumigation in that following removal of the gases by suction, fresh air is forced with the same intensity through the objects, thus quickly removing any remaining fumes.

However, the destruction of harmful agents in wood, textiles, etc., by treatment with highly lethal gases demands a reaction time of many hours even when using a by-pass system in a pressure chamber since the gas must penetrate the objects under air pressure. More than just small amounts of the gas, especially if it is water soluble, are retained on the surface of the objects. They are therefore lost for use against harmful organisms. An increase in the gas concentration does not usually make much of a difference except to result in a larger surface concentration. The amounts that actually reach the inside of the objects will always be small and in some cases insufficient for successful fumigation.

Vacuum fumigation

Compared with the above, fumigation in a vacuum brings important advantages. Because of the greatly reduced air pressure, the injected gas can almost instantaneously penetrate into the inside of the objects. Furthermore, the withdrawal of oxygen increases the lethal effect of the gas. Vacuum chambers are furnished with a by-pass system which enables in a constant vacuum not only a rapid and regular distribution of the fumigant but also a short ventilation period. In contrast to working under air pressure, one can reduce considerably the costs for gas and operating time with vacuum fumigation to less than one-tenth of the time necessary with atmospheric pressure. If of the same size, a vacuum chamber accomplishes many times more than a normal pressure chamber.

The low pressure prevailing in the chamber guarantees increased safety for service personnel: 1.) in case of leakage, the gas can

not escape but at most fresh air penetrates the system; 2.) the danger of explosion is eliminated by the practical absence of oxygen.

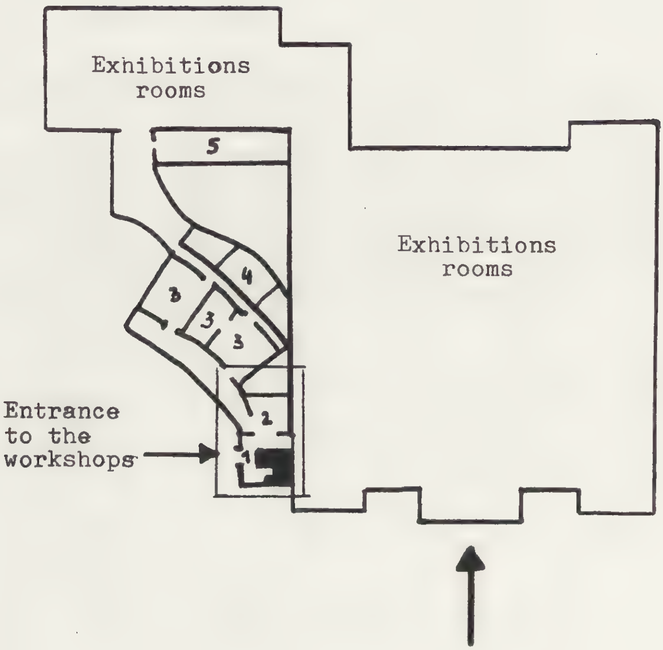
To ventilate repeated evacuations and rinsings with fresh air - which should naturally be filtered for purposes of degermination and sterilization - suffices to remove any gas residues. The fumigated objects can generally be handled very soon after removal from the chamber. If large amounts of gas have been used (degermination, sterilization), however, an extra airing out phase in a suitable room should be added.

Besides ETOX (already mentioned), ETOXIAT (a mixutre of 45% ethylene oxide, 45% methyl formate and 10% carbon dioxide) is used for fumigation. This compound is distinguished by its broad efficiency spectrum, which includes the destruction of moulds. The dosage for ETOX as well as for ETOXIAT is approximately 1500-2000 g/m^3 with a reaction time of only two to six hours.

In fighting animal pests two gases are available: hydrogen cyanide (ZYKLON), dosage 20 g/m^3, and methyl bromide (HALTOX), dosage 50 g/m^3. The reaction time in these cases must be increased to 24 hours.

Our common goal should be the timely recognition and destruction of wood and textile pests. The appropriate use of highly lethal gases such as hydrogen cyanide, methyl bromide and ethylene oxide guarantees the eradication of all insect pests.

Fig. 1



1 : Fumigations Chamber
2 : Airing room
3 : Workshops, Preparation
4 : Restauration department
5 : Chemical laboratory

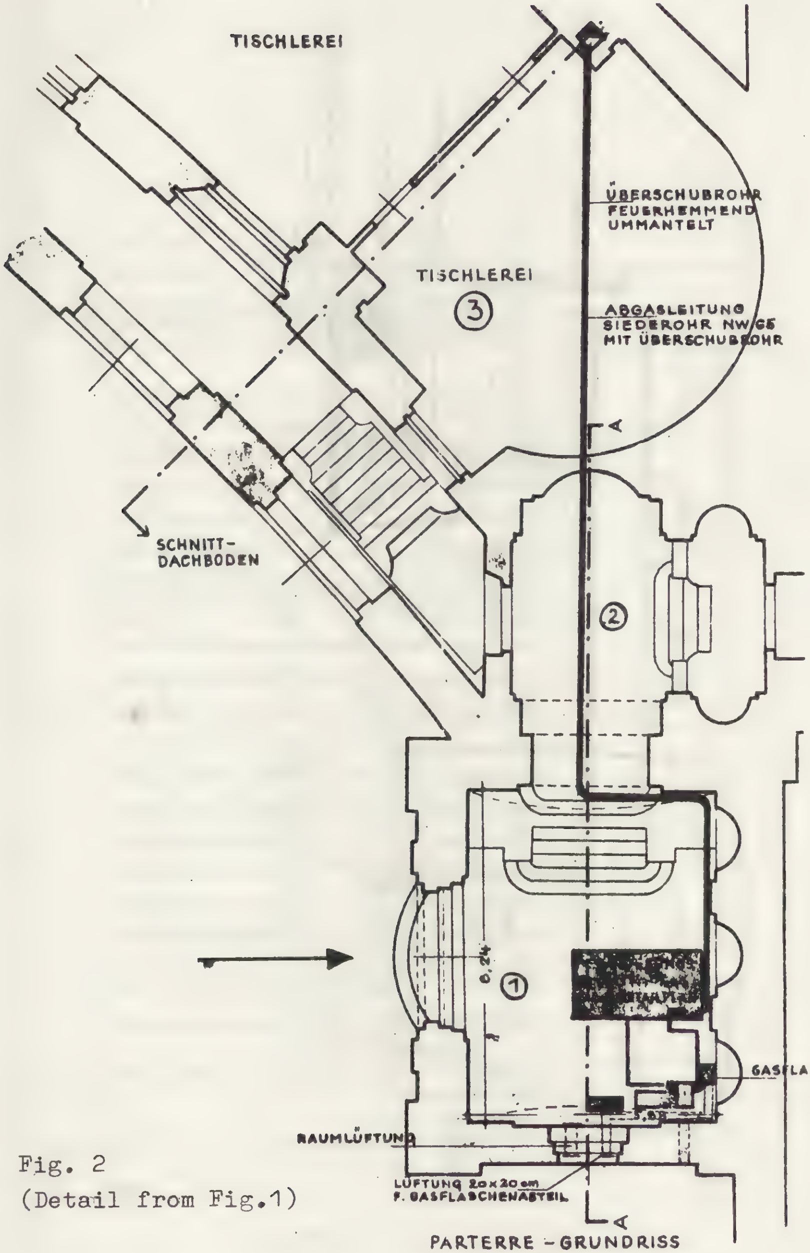
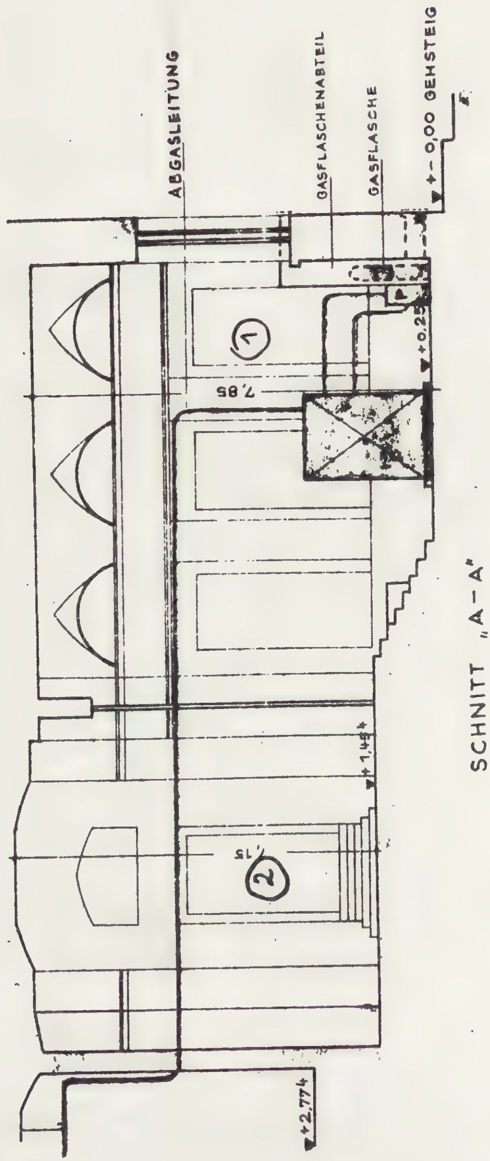


Fig. 2
(Detail from Fig.1)

78/3/6/10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1
+1.45
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2
+2,774
SCHNITT „A-A"

Fig. 3

Fig. 4

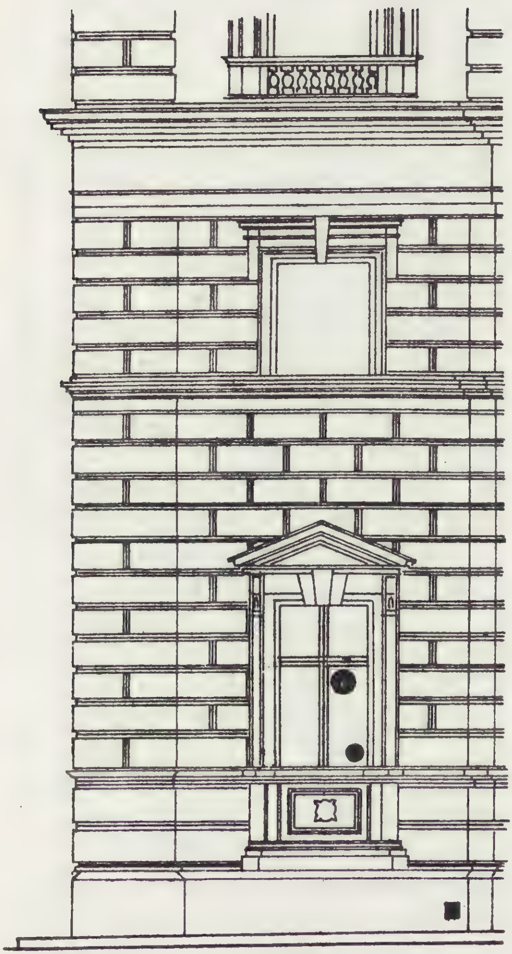

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Fig. 5

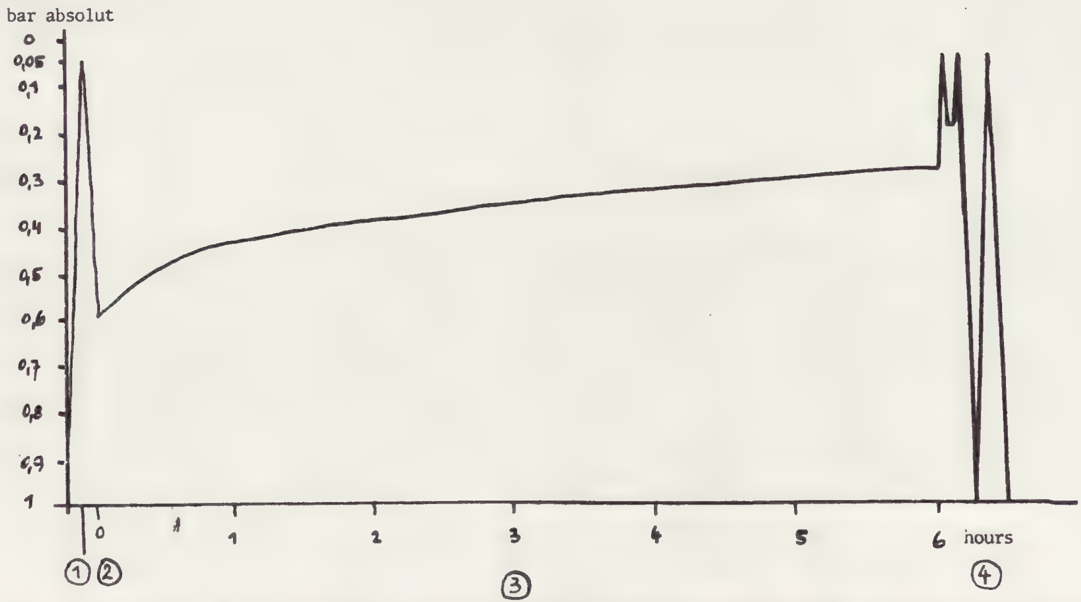


Diagram of a fumigation process with ethylene oxide

1) Evacuating
2) Entrance of the gas
3) Time of fumigation
4) repeated evacuation and sweeping with fresh air

WATER SOLUBLE PLASTICS IN THE PRESERVATION OF ARTIFACTS MADE OF CELLULOSIC MATERIALS

Erica Schaffer

ABSTRACT

The solubility of films of hydroxyethyl -, hydroxypropylmethyl -, sodium carboxymethyl cellulose; polyvinyl alcohol, polyethylene glycol were examined after 450 hours of UV irradiation and found to be unchanged. Similar results were obtained with respect to solubility when the above polymers were used as consolidants in sound eastern white pine samples. Impregnation with these polymers caused slight shrinkage except in the case of polyethylene glycol. The mechanical strength of the consolidated wood samples improved significantly as indicated by the modulus of elasticity.

Artifacts made of cellulosic materials form an important and extensive segment of ethnological and archaeological collections. Wood and basketry are the two most noteworthy groups from a material culture point of view.

Cellulose being a biological substance, is under normal environmental conditions susceptible to deterioration due to physical factors as well as biological agents. As a consequence, most artifacts made of cellulosic materials ideally require consolidation before they can be exhibited or even studied.

Of the rather large number of polymers suitable to act as a consolidating agent only those which are water soluble were considered in this study. These substances offer the great advantage of eliminating the need for drying waterlogged materials prior to impregnation. Removal of all the water from large artifacts can be a time consuming task which itself may weaken the materials by creating the so-called drying stresses (1)

Two further conditions were accepted in the planning stage of the work: the consolidating treatment must not noticeably alter the appearance of the artifact, and the treatment should be reversible.

The first condition has always to be accepted in preservation work but the second one gained more attention only recently.

In "The Conservation of Cultural Property" a handbook prepared by UNESCO it is stated..." the term reversibility is used here in the sense that a conservation method can be reversed if anything unexpected should happen, so that the object can be recovered in its original state undamaged. This principle is paramount when any material, whether natural or synthetic is applied to a very valuable object eg. a painting and in such cases absolutely.

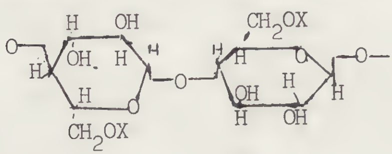
However, in the conservation of many archaeological objects, particularly when consolidation is necessary, it may be permissible to carry out an irreversible process using materials which have been thoroughly tested on trial objects."

In many instances ethnological materials received by museums for preservation are in deteriorated condition. The degree of degradation they suffered is never uniform and varies even within the same piece, also often important data are missing about the environmental conditions under which deterioration took place. For these reasons objects are seldom if ever available which are sufficiently similar to the artifact making trial treatments possible. Reversibility of the treatment applied to archaeological and ethnological materials is highly desirable and should be mandatory if possible. Such policy has been adapted by several institutions. The aspect of reversibility is therefore of great interest to conservators.

1. Materials.

Several classes of water soluble polymers were included in the study.

Nonionic type cellulose ethers. Hydoxyethyl cellulose (HEC): Cellosize WP-09 (manufactured by Union Carbide Corp.) a 5 percent aqueous solution of which has a Hoeppler viscosity of 120-160 cps and Cellosize WP-3-H which has a viscosity of 325 - 400 cps under similar conditions. Hydroxy-propylmethyl cellulose (manufactured by Dow Chemical Corp.) having a viscosity of 4000 cps in a 2 percent aqueous solution. The formula of these polymers is given below

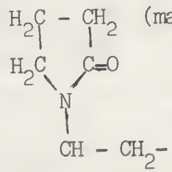


X = CH_2CH_2OH hydroxyethyl cellulose

X = CH_2COONa sodium carboxymethyl cellulose

Anionic cellulose ether Sodium carboxymethyl cellulose (NaCMC) Cellosize CMC P-75-M (manufactured by Union Carbide Corp.) A 2 percent aqueous solution has 300 to 600 cps Brookfield viscosity.

Polyvinylpyrrolidone (PVP) (manufactured by GAF Corp.)



in three grades: K-30, average molecular weight 40,000; K-60, average molecular weight 160,000; and K-90, average molecular weight 360,000.

Polyvinyl alcohol (PVA) - $CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}$ -

Mowiol 4-88 and Mowiol 40-88 (manufactured by Hoechst A.G.) The DIN viscosities of 4 percent aqueous solutions are 4 and 40 respectively.

Polyethylene glycol (PEG) - $\underset{\displaystyle OH}{\underset{|}{CH}} - \underset{\displaystyle OH}{\underset{|}{CH}}$ - (manufactured by Union Carbide Corp.)

in four grades: 300,600,1000 and 4000.

All the above polymers readily dissolve in cold water with the exception of Mowiol 40-88 and polyethylene glycol 4000, which required heating to moderately elevated temperatures (60-85°C)

Wood - Flat grained veneer specimens were cut of eastern white pine. In the first impregnation experiments the thickness of the specimens was 5.5 mm, but in the latter ones this was reduced to 2.5 mm in order to shorten the time required for impregnation.

2. Aging of polymer films.

In the first phase of the study the effect of aging on the solubility of films of the various polymers was determined.

Few drops of aqueous solutions containing one or several of the polymers were deposited onto glass microscope slides which were then exposed to the atmosphere. After evaporation of the solvent polymer films formed on the glass slide.

The slides were exposed for 450 hours to continuous UV irradiation (carbon arc) in a Weather-O-Meter in which the water spray was disconnected.

After irradiation the microscope slides were immersed in water, heated up to 60-85°C if required, and the solubility of the films assessed. Details of the experiment are summarized in Table 1.

Composition and solubility after aging of consolidants

Designation	Composition	Solubility after aging
B_1	NaCMC	soluble
B_2	NaCMC + PVP K-60 (20%)	soluble
B_3	NaCMC + PVA 4-88 (20%)	soluble
B_4	NaCMC + PEG 200 (20%)	soluble
B_5	NaCMC (40%) + PEG 200 (20%) + PVP K-60 (20%) + PVA (20%)	soluble, traces of minute gel particles

Designation	Composition	Solubility after aging
C_1	HEC WP-3-H	soluble
C_2	HEC WP-3-H + PVP K-60 (20%)	soluble
C_3	HEC WP-3-H + PVA 4-88 (30%)	not soluble completely
C_4	HEC WP-3-H + PEG 200 (20%)	soluble
C_5	HEC WP-3-H (40%) + PEG 200 (20%) + PVP K-60 (20%) + PVA (20%)	soluble, traces of minute gel particles
D_1	HEC WP-09	soluble
D_2	HEC WP-09 + PVP K-60 (20%)	soluble
D_3	HEC WP-09 + PVA 4-88 (20%)	soluble
D_4	HEC WP-09 + PEG 200 (20%)	soluble
D_5	HEC WP-09 (40%) + PEG 200 (20%) + PVP K-60 (20%) + PVA (20%)	soluble, traces of minute gel particles
A	PVA	soluble
P	PVA + PVP K-60 (20%)	soluble, traces of minute gel particles
W	PVA + PEG 1000 (20%)	soluble
5	NaCMC (31%) + HEC WP-09 (31%) + PVP K-60 (31%) + PEG 200 (7%)	soluble, traces of minute gel particles.
6	HEC WP-09 (24%) + PEG 200 (70%) + PVP K-60 (3%) + PVP K-90 (3%)	insoluble gel

2.1 Results. The solubility of the films formed of single components, such as NaCMC, HEC, and PVA was not affected by UV irradiation lasting 450 hours. The addition of 10% PVP K-60, or PEG 200, or PVA to these polymers, specimens designated B_2, C_2, D_2; B_4, C_4, D_4; B_3, D_3, respectively, did not decrease the solubility of the irradiated specimens. The film of HEC' WP-3-H containing 10% PVA, however, became brown in color and insoluble even in hot water after exposure to UV irradiation; boiling in water resulted in the formation of a brown suspension without complete dissolution of the film.

The systems B_5, C_5, and D_5 which contain four components, cellulose ether, PEG, PVP and PVA become less soluble after UV irradiation. Although the film dissolved, the liquid phase contained small gel particles which may have been the product of a reaction among the constituents. It is also possible that the UV light promoted the formation of cross linkages in PVP which is known to be prone to do so. (2)

The fact that PVA remains water soluble (sample A) after 450 hours of exposure to UV irradiation proves that no cross-linking between the polymer chains had taken place. This is not too surprising, because both PVA 4-88 and 40-88 are partially saponified acetate copolymers, composed of 7-12 percent polyvinyl acetate and 88-93 percent polyvinyl alcohol, (3). One component, the polyvinyl acetate is well known for its stability with respect to light including the UV region of the spectrum, (4). In case of PVA the molecular chain has strong linkages, due to the tendency of the monomer molecules to arrange themselves in a head to tail manner:

$-CH_2-\underset{OH}{CH}-CH_2\underset{OH}{CH}-CH_2\underset{OH}{CH}-$ In many instances, however, an abnormal PVA fraction, a byproduct is formed in the polymerization, amounting to about 1-2% of total PVA, in which the monomers join in a head-to-head, tail-to-tail arrangement

$$-CH_2-\underset{OH}{CH}-\underset{OH}{CH}-CH_2-CH_2-\underset{OH}{CH}-\underset{OH}{CH}-CH_2$$

In this formation the hydroxyl groups are attached not to alternate but adjacent carbon atoms, forming 1, 2-glycols. The bond in 1, 2-glycol is relatively weak and can be cleaved with oxidizing agents such as H_2O_2, especially in the presence of Cr, Cu or Fe ion Catalysts and at elevated temperatures (above $90^{\circ}C$) (5). This molecular degradation yields free aldehyde radicals, which combine with the alcoholic hydroxyls of the adjacent chains rendering the product insoluble.

Because aged PVA films remained water soluble it must be assumed that a) either there were no compounds with hydroxyl groups on adjacent carbon atoms present in the PVA tested in the present experiments and thus no fraction was prone to cross-linking and b) no compounds capable to cross-link are produced in PVA by irradiation with UV light, a behavior in contrast to that of certain methacrylicester polymers. (6) Cross-linking of PVA is expected to occur however, in the presence of catalysts; or oxidizing agents particularly at elevated temperatures. (7)

It has thus been established that several polymers retain their water solubility after exposure in a Weather-O-Meter for 450 hours. For expressing this time in terms of museum exposure Dr. Feller's estimation is (8) that 25 ± 10 hours of Fadeometer exposure is comparable to the effect of 82 years of museum conditions (60 foot candle incandescent light illumination). On this basis 450 hours in Weather-O-Meter is equivalent to approximately 1054 to 2460 years exposure under museum conditions. Extrapolation to that extent is uncertain and the numerical values probably unrealistic. It may be concluded however, that several polymers usable as consolidant show no indication of losing their water solubility on aging.

3. Aging of polymers infiltrated in wood.

The next phase of the study dealt with the effect of UV light on PVA dispersed in the crevices of wood. Because of the possibility of UV radiation inducing chemical reaction between PVA and the wood substrate leading to a decreased solubility of the polymer this aspect is of great interest to convervators.

The flat grained eastern white pine specimens were 88 mm by 50 mm by 5.5 mm in size. The specimens were kept immersed in a PVA solution for three weeks, after which they were exposed to the UV radiation of a carbon arc in the Weather-O-Meter for 19 days. The specimens were then leached in water to assess the solubility of the aged PVA.

Quantitatively the agreement was quite satisfactory. In one case the sample conditioned at 56 percent relative humidity absorbed 0.8968 g PVA, corresponding to 8.91 percent of the conditioned weight of the wood, and the weight of the dried extract obtained on leaching was 0.8725 g. Thus 97.3 percent of the infiltrating polymer appears to have been regained.

In order to identify the extract, that it is indeed the impregnating polymer and nothing else, the dried residue was dissolved in water and the infrared absorption spectra of the solution was determined with a Perkin-Elmer Model 621 grating spectrophotometer. On comparing the spectra with that of the impregnating PVA solution (Fig. 1), it can be concluded that

a) the extract is indeed PVA,
b) no additional material as impurity was leached from the wood. This was to be expected because the eastern white pine has a very low water extractable content, the very property for which it was selected for this study. The total weight of the dried extract can thus be considered as that of PVA.
c) furthermore, no aging or other change in the PVA could be detected by the infrared spectroscopy. This means that neither the wood substance nor the extensive ultra-violet irradiation altered the solubility of PVA.

Some samples were examined in a Cambridge scanning eletron microscope in their original untreated, impregnated and extracted state. The electron micrographs of Figure 2 reveal the consolidation of small fibers, the disappearance of "fuzziness" at the edge of the large bundles on impregnation. This change is beneficial and of course, to be expected.

The distribution of the polymer in the wood was checked by determining the NaCl concentration mixed into the impregnating solution as a tracer, at various locations of a 2.5 mm thick PVA impregnated flat grained veneer specimen. Energy dispersive x-ray analysis was performed with a Tracor Northern instrument. The

counts proportional to the chlorine concentration in 100 second intervals are given in Table 2. It can be seen that the distribution of chlorine was essentially uniform indicating an even coat of polymer and no polymer blobs were detected.

Table 2

Energy dispersive x-ray analysis of wood samples impregnated with NaCl containing PVA.

Frame No.	Magnification	Cl Count/100 second	
1	500 x	792	avg
2	500 x	906	avg
3	500 x	838	avg
4	500 x	765	avg
5	1000 x	759	spot
6	1000 x	702	avg
7	500 x	883	avg
8	500 x	593	avg
9	500 x	728	spot

In order to resolve whether some of the PVA can be leached also from the cell walls sample were impregnated under 50 atm pressure. The specimen was 25 mm by 5 mm 2.5 mm in size and was kept in the PVA solution for 48 hours. Prior to use the solution was boiled for one hour to remove the aldehydes, and to precipitate the highly reactive abnormal PVA fraction, should these components be present. The impregnated specimens were irradiated in the Weather-O-Meter for five days. By leaching 0.0386 g extract was regained, which is 119.5% of the originally absorbed PVA. The 0.0063 g weight excess may be due to extractive originating from the wood. The experiment proved that even under pressure introduced PVA can be leached out from the UV irradiated wood.

4. Dimensional changes.

From a conservation point of view an increase of dimensional stability is very desirable. In addition, dimensional change measurements are useful also because they can yield information on the state of the wood. For these reasons the measurement of this factor was also undertaken in the experimental program.

Eastern white pine flat grain veneer and fungi infested deteriorated pine were included in the study. The weathered pine had most of its fibers broken down and could be easily fragmented with fingers.

The measurements were performed with a dial gauge with 0.00254 mm (0.0001 inch) sensitivity. The gauge was checked with a calibrated bar before each reading.

All samples for experiments with sound wood were cut tangential to the growth rings from the same log. The dimensions of wood change the most in the transverse, across the grain direction, and, therefore, this dimension was selected for the measurements. The

specimens were cut in such a manner that their longest dimension, 91 mm, was in this direction in order to increase the sensitivity of the measurement. The deteriorated specimens were of various sizes depending on the condition in the particular region of the stock material.

Because the dimensions of wood depend not only on its moisture content but also on the path (wetting or drying) a given moisture content was reached, the samples were dried in air before measurement and then conditioned for seven to ten days in a desiccator over a saturated $Mg(NO_3)_2$ solution, which produced 56 percent relative humidity.

Before impregnation the specimens were conditioned in order to establish the dimension which was then to serve as reference. Subsequently the specimens were immersed in aqueous solutions of the polymers the concentration of which was at first rather low in order to facilitate penetration but later was increased as impregnation proceeded. By the use of small spacers infiltration of the liquid also from the lower surface of the samples was assured. In samples conditioned at 56 percent relative humidity the moisture content is approximately 10 percent of the oven dried weight of the wood and the dimension in the measured direction is approximately 2.6 percent larger than in the completely dry state. On impregnation the specimens are immersed and swell partly because they become fully water saturated and possibly because of the impregnation itself. In a wood that has not been impregnated this dimension at the fiber saturation point is 7 percent larger than in the oven dry state (9) thus on increasing the moisture content from 10 percent at 56 percent relative humidity to the fully saturated state results in an appr. 4.4 percent expansion due to wetting alone. This relatively large expansion occurs only if the wood is sound. The decayed wood expanded under similar conditions only by approximately 2 percent.

After 10 to 14 days the samples were removed from the impregnating solution, drained of excess liquid, lightly wiped and dried in air for two days. Hysteresis effects were avoided by approaching the reference state again from the dry state.

The specimens usually became warped due to the non-uniform moisture distribution but on reconditioning at the reference 56 percent humidity the warpage decreased.

The dimensional changes due to impregnation measured in the reference state are shown in Table 3.

It can be seen that PVA, PVA PVP, PVA PEG, PVP and HEC on infiltration into sound wood results in moderate shrinkage. In contrast PEG causes swelling. With the exception of PVA decayed wood appears to expand when impregnated.

Table 3

Dimensional changes in the transverse direction of eastern white pine wood samples due to impregnation, measured at 56% R.H. Std. conditions.

SOUNDWOOD

Polymer	Sample No.	Polymer absorbed wt% of conditioned wood	Dimensional change %
PVA Mowiol 4-88	3 4 13 14	21.34 19.15 25.83 26.46	- 0.67 - 1.43 - 0.36 - 0.95
PVP Mowiol 4-88 PVP K-30 (10%)	1 2	21.94 22.19	- 0.79 - 0.47
PVA Mowiol 4-88 PEG 1000 (10-20%)	11 12 17	27.11 22.90 33.20	- 0.35 - 0.22 - 0.12
PVP K-30	9 10	51.27 57.39	- 0.37 - 0.42
Cellosize HEC WP-09	5 6	13.50 11.60	- 1.08 - 1.01
PEG 4000	7 8 15 16 18 19 20 21 22	69.22 61.63 62.19 64.11 59.53 46.99 94.29 87.99 48.92	2.43 2.29 2.38 2.23 0.92 1.22 2.66 2.21 1.55

DETERIORATED WOOD

Polymer	Sample No.	Polymer absorbed wt% of conditioned wood	Dimensional change %
PVA Mowiol 4-88	31 IX	50.75 142.8	- 0.12 - 3.22
PVP Mowiol 4-88 PVP K-30 (10%)	36 37	117.25 101.45	0.36 1.00
PVA Mowiol 4-88 PEG 1000 (10-20%)	32 33 XXII	77.03 44.19 198.13	0.82 0.74 1.03
PEG 4000	34 35 40 41	577.38 407.97 398.39 242.15	2.88 2.31 1.91 1.41

4.1 Discussion

The dimensional changes in response to changes in moisture content of the deteriorated wood was found less than those of the sound wood. This result is consistent with the relationship

$$S = fg$$

where S is the volumetric expansion in percentage based on the volume of the oven dried wood, f is the moisture content at the fiber saturation point on a percentage volume per unit weight basis and g is the specific gravity of the wood on a dry volume basis. S of the deteriorated wood is expected to be small by virtue of the low value of g.

The value of the dimensional change of sound wood is affected by several factors.

1. The value of the fiber saturation point i.e. the moisture content at which desiccation of saturated wood causes noticeable shrinkage with the type of wood.

2. The magnitude of shrinkage in response to a given change of environmental humidity which varies from timber to timber.

3. The method of drying which affects the dimensional changes depending on the extent of the collapse of the cell walls.

4. The temperature of seasoning that reduces the expansion values

if so high temperatures were employed that the hemicellulose component broke down.(10)

For these reasons the experiments were not designed to obtain quantitative dimensional change values representative of wide range of wood species but rather to compare the effect of the various polymers on wood in a qualitative sense.

On evaporation of water, moisture is removed primarily from spaces between the fibrils and curved (concave) water-vapour interfaces are created which through surface tension forces tend to draw the chains together. For this reason changes in dimensions are most pronounced in a direction that is perpendicular to the main axis of the fibrils. (11) . In impregnated wood after the evaporation of water a polymer coat is formed which keeps the fibers together, diminishing the extent of the expansion in response to wetting.

5. Mechanical strength.

The improvement of the physical properties of the specimen due to impregnation was assessed by the measurement of Young's modulus, or modulus of elasticity.

Discs of 3.8 mm diameter were cut and sanded. The deformation of the specimen was determined in a three point loading test. By applying weight to the disc supported in three points, a bending or flexing action takes place. The convex surface formed by bending is under tension and the concave surface under compression, also shearing stresses are set up parallel to the grain between the various imaginary lamina that makes up the specimen.

In static bending the modulus of elasticity is equal to the slope of the linear portion of the stress-strain plot.

Young's modulus is the stress required to produce unit strain which is the change of dimension. The modulus is a measure of rigidity or stiffness.

The measured values are given in Table 4. The untreated decayed wood was so fragile it crumbled when attempts to cut specimens were made.

Table 4

Young's modulus of untreated and impregnated eastern white pine and consolidated decayed pine.

Sample description	Young's modulus kg/cm^2	Percent increase
	Sound Wood	
untreated	3045	--
HEC	3625	19
PVP 4-30	6495	113
PVA 4-88	7163	135
PVA PVP K-30	3842	28
PVA PEG 1000	4721	55
PEG 4000	9060	197
	Decayed Wood	
PVA PVP K-30	537	
PEG 4000	497	
PVA PEG 1000	2019	

5.1 Discussion

Barkas (12) points out that:

"the cell structure of wood is not just a simple gel system, but a gel system the properties of which are affected on its past history. Its response to a given end point of an experiment may depend on the way in which that end point has been reached. For this reason every sample of gel tends to acquire individual properties and it is difficult to devise experiments so as to give a set of correlated data of several properties all applicable to the same material.

Even the Young's moduli of several samples of wood cut from a single large piece may show a two-to-one variation."

Then he cautions "for this reason we have to be cautious in accepting experimental results on small samples as typical of the material or in accepting a theory on the strength of a limited supporting evidence."

Notwithstanding the values indicate an increase of 19 to 197 percent in Young's moduli due to impregnation with various polymers. The main conclusion of these results is that consolidation with water soluble and reversible polymers undoubtedly improves the physical properties of wood and that improvement is significant. The decayed frail wood samples show also great improvement in properties although the values are far smaller than those of sound wood.

6. Conclusion

1) A number of water soluble polymer potentially suitable for consolidating deteriorated wood remains water soluble after 450 hours of UV irradiation when in the form of a film supported on microscope slides.

2) The polymers also when infiltrated in eastern white pine remained reversible with respect to water solubility.

3) On infiltration all examined polymers, with the exception of PEG, cause shrinkage of the sound wood.

4) The mechanical properties of sound and deteriorated wood improves significantly when infiltrated with water soluble reversible polymer. The details of the treatment will be the subject of a forthcoming publication.

Acknowledge

I am much indebted to Mr. D. B. Alsford, Curator of Collections for reading the manuscript and helpful comments; to Dr. M. Y. Cech of The Eastern Forest Products Laboratories, for donating the sound wood samples, and for his cooperation and helpful discussion. I gratefully acknowledge the kind cooperation of the National Research Council in carrying out some of the physical measurements.

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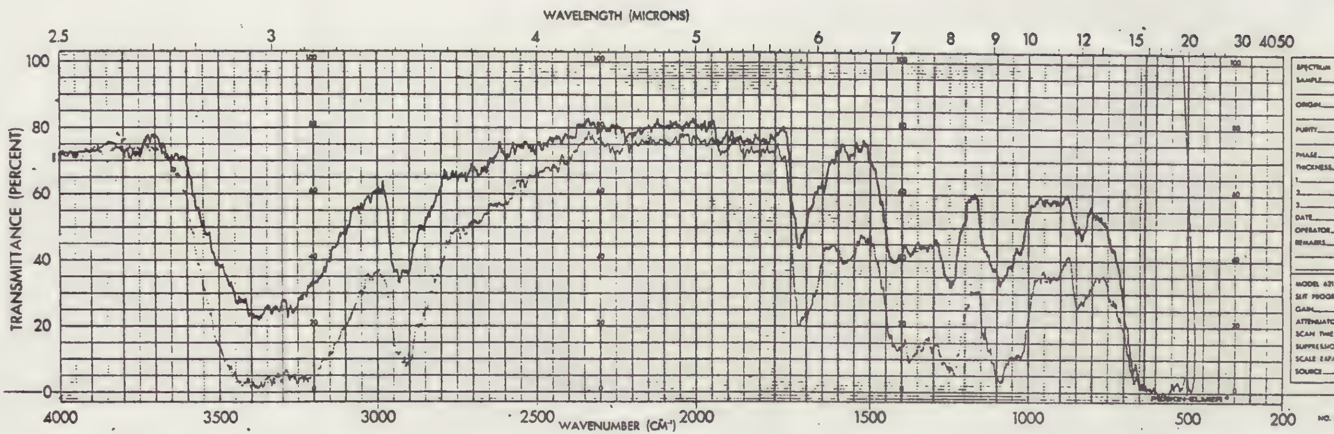

Fig. 1. Infrared spectra of the impregnating solution (lower spectra) and the extract dissolved in water (upper spectra)
Perkin-Elmer grating spectrophotometer, Irtran support.

Fig. 2.

Electron micrograph of untreated (a), impregnated (b), and extracted (c) wood.
Magnification 500 x

DOCUMENTATION

Coordinator : Y. Grenberg (USSR)
Assistant coordinator: H. Barker (U.K.)
Members :

Programme 1975-1978

1. Design of computer compatible conservation record cards (as member of the IRGMA/IIC joint working committee in the U.K.) (Barker).
2. Elaboration du système d'information de recherche, simple et convenable pour tous les musées du point de vue économique, destiné au rassemblement, à la conservation et la livraison des informations partant des sources écrites, qui fournissent les données sur la technique et les matériaux de la peinture (Grenberg).
3. Elaboration du système d'indexation, assurant une introduction le plus simple des informations recueillies dans le système et leur livraison (Grenberg).

DOCUMENTATION OF CONSERVATION IN MUSEUMS: THE QUEST FOR A SOLUTION

Harold Barker

In the U.K., since 1974, a working party of conservators and information scientists have been examining the problems of documenting conservation in museums and similar institutions. The results of their deliberations have been brought together in a publication entitled, "Proposals for the Documentation of Conservation in Museums" available from the Museum Documentation Association, Museum Documentation Advisory Unit, Imperial War Museum, Duxford, Cambridgeshire CB2 4QR, England. This publication is intended as a guide to those concerned in setting up information systems and is particularly useful in that it outlines the major decisions which have to be taken at an early stage in the design of a system and describes the two main approaches which may be followed in order to implement these decisions. In brief, it is necessary to decide (1) how much information should be recorded about the object and the conservation process, (2) how much of the information must be structured rather than in free text form and (3) what method of structuring is to be used.

In considering these questions it is assumed that the answer to the first would be that all conservators would wish to include as much information as possible in the record. However, the correct answers to the other two questions are not easy to arrive at and some compromises have to be made in order to reach a practical solution.

Effective systems of information processing require the information input to have a highly formalised structure which often requires considerable mental effort and sometimes special training on the part of the conservator who would naturally much prefer to record information in free text.

The art of designing a successful system thus consists of striking an appropriate balance between a structured and an unstructured record. These problems are well illustrated by two alternative designs described in the M.D.A.publication. Both are based on the use of keywords as a means of sorting and locating information, but the first card is much more highly structured than the second, being intended to be used as a structured summary of the main conservation record which would be kept elsewhere. The second card tends towards the opposite extreme in which the full information is recorded in free text from which a list of appropriate keywords is prepared.

The second card would clearly be easier to use as a record card from the conservator's point of view since it requires little more effort than in using a notebook to record the facts of the

work. However it suffers from severe limitations when used as a source of information since the list of keywords would be unstructured, and as a result any form of selection by keyword would inevitably include many irrelevant records as well as the ones required. The more highly structured index card does not suffer from this disadvantage, but does require much more effort in order to ensure that the facts are accurately recorded. Clearly it is possible to base the design of a system anywhere between these two extremes, and the value of the M.D.A. publication lies in the guidance it provides for those who wish to design their own system as well as providing ready made solutions for the less adventurous. In practice, it seems likely that the more highly structured card, perhaps in slightly modified form, will be made available in the near future to complement the series of museum catalogue cards which are already obtainable from the Museum Documentation Association.

MUSEUM CATALOGUING AND THE COMPUTER

Y.A. Chere and A.O. Polyakov

The setting of the problem

Introduction of computers into museum practices is taking real shape and the prime subject of nowadays is the choice of the most efficient conditions to store, retrieve and process information about museum collections rather than potential application of computers in museums as it was the case ten years ago. (1)

At the first stage of the build-up in museum informatics the development of adequate formalized structures for computer-oriented description of museum collections offered a major challenge. Since the problems were approached by specialists combining museum expertize with apprehension of requirements for computer operation the conversion of data from the museum science language into machine languages was though elaborate but, nonetheless, quite surmountable.

Now we are facing the problem of providing any museum worker and above all those with no training in computer operation with a simple and efficient access to data banks and museum computer networks. In this situation, one comes up with an alternative of either retraining the entire museum personnel in computer operation techniques or making the computer "learn" the museum science language. Considering the latter approach as the most efficient the authors endeavou-

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(1) Computers and their potential applications in museums. New York, 1968.

red to set a task of modelling a similar computer education routine, thus developing such a model of the museum information retrieval system which would enable a museum worker to communicate in a familiar language with practically no special training.

Problems of communication with the computer

An ordinary operational scheme of a museum data bank realized in batch processing conditions has the following features. The memory holds in store mainly recording data about museum exhibits, i.a. author, date, name, size, price, inventory number, participation in exhibitions, etc. Data of scientific nature is usually disregarded to a greater extent due to the complexity of its formatized description. (2) Thus, a file of facts most valuable to the museum worker is omitted from the sphere of automatically controlled information service. This alone substantially depreciates in his eyes the quality of information stored in the data bank.

To enable the museum worker with humanitarian background to make use of the data bank an "interpreter" is required. Information inquiry expressed in a natural language is submitted to the data bank service staff. The inquiry is then translated into a machine language and undergoes computer processing. The answer given by the computer is later translated back into a natural language to be delivered to the user.

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(2) See, for example, D.Vance, Museum Computer Network. The second phase. "Museum News", Washington, v. 48, n. 9, 1970, pp. 15-20; D.Vance, Museum Computer Network. The third phase. "Museum News", Washington, v. 51, n. 8, 1973, pp. 24-27.

Waiting time required to produce an answer exceeds immeasurably machine cycle transit time whereas it is quite commensurate (due to narrow specialization of museum workers) with manual information search time spent on literature, card-files and other information mediums. What is more, manual retrieval comes hand in hand with continuous inquiry correction while such correction in data bank handling is not practically feasible. If the inquiry is not formulated by the user clearly enough the answer will be unsatisfactory just as well, whereas a corrected inquiry would require full repetition of the entire machine cycle involving a corresponding period of waiting for an answer without any guarantee of the computer giving the very answer the user interested in obtaining instead of something similar formally but quite different in its essence.

After performing such multiple references aiused at correcting the initial inquiry the aggregate waiting time obviously exceeds the time of comparable manual information retrieval in libraries, archives and other documentation depositories.

In this connection, the recent report of one of the leading experts in humanitarian informaties, J.-C. Gardin, sounds well proved. The author analysed in detail the efficiency of data bank operation on historical sources (history, archaeology, ethnography, art) noting that "they were referred to extremely rarely though nothing could be easier". (3) It seems to be one of the major paradoxes of the current stage of museum informatics development.

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(3) J.-C.Gardin. Logical effects of data bases on the study of historical sources. "Int. Soc. Sci. J.", vol. XXVII, n. 4, 1975, pp. 761-776.

One of the ways to get over this paradox appears to come from providing the museum worker with a possibility to communicate directly with the computer in a natural language or in a language as closely allied to a natural language as possible. The museum worker would be given an inward impulse to approach the computer with more sophisticated questions including in formation and logical problems of research character, provided the language barrier in communication with the computer is removed while solving relatively simple information retrieval problems. This, in its turn, would inevitably contribute to the advances in technical culture of specialists with humahitarian expertize, helping them master more complicated algorithms and improve skills in communication with software experts. In other words, what the museum worker is lacking for successful computer utilization should be gained by way of essential practical problem-solving, moving from the simple to more complex, rather than by emphasizing abstract propaganda.

Mini-bank in conversational mode of operation

Proceeding from the task defined in the above manner the Informatics Bureau of the State Hermitage and the Research Automation Sector of the Leningrad Computer Centre of the USSR Academy of Sciences have mutually built an operative model of a museum data bank making use of a very limited documentation content. The Antique Bronze Catalogue performed the function of an experimental data file. The retrieval pattern of a document was formed in such a way as to incorporate both registration data of museum accounting and other features facilitating the assigument of retrieval and classification problems to the computer in various aspects: iconographic, stylistic, chronological, techno-

logical, etc. One of the ingredients of the retrieval pattern is the data about the passage of an exhibit through different restoration procedures as well as physical and chemical research arrangements. Certain roadblocks come in the way when trying this approach, especially at the first stage. But those are the hardships of data base development experts, not users. The pacing factor enjoying the greatest attention has been the provision of the user with direct access to the data bank.

Like it happens with SINTOL, words and expressions are initially written in a natural language while their conversion to machine recording is "hidden" from the user and does not cramp his actions. After a call is Placed a brief instruction is displayed on the cathode ray tube for the user outlining the sequence of his action (Fig. 1). Input operation is performed by the user himself addressing his inquiry in the form of a list of features of interest stated in a natural language with a minimum number of formal additions: indexes of input beginning and end; semicolon as a separator; indexes of deleting and supplemental sigus. The input end index automatically incorporates the retrieval program. When the program is passed through, the answer in a natural language is displayed on the tube as a list of item names indicating inventory numbers and other information stored in memory. This list is presented as a table which is arranged according to the level of conformity with the inquiry. So, should an item cover a full list of features indicated in the inquiry, it would be accompanied by 100 per cent index, whereas an incomplete list makes index value drop accordingly.

Along with mastering habits of communication with a bank model its performance could be also improved. For example, at the first stage of training it is more convenient for the user to read such displayed expressions as: "Do you want to correct your inquiry in any way?" or "Does the notion of "curos" equal that of "nude youth"?", etc., while at a later stage the user would find it more appropriate and economical to have answers like: "corrections?" or "corr.?"; "curos=nude youth?", etc. At the beginning, the user tends to expect a fuller list of items displayed for visual inspection so that afterwards a stricter selection is made all by himself. After a while, he would be able to assign the task to the computer by consequently loading it with a more complex program. The model is, therefore, able to suit itself to the user's level of Know-how, giving him a possibility of solving increasingly complicated problems on the basis of accumulated skills the way an experienced teacher would do.

Possible mastering of external aspects of the user's communication is not the only problem solved by handling the given model of a museum data bank.

Generally, while designing information retrieval systems the compilation of a thesaurus covering all lexical units of an information retrieval language with their synonyms and word combinations in a natural language is one of the hardest and time - consuming preparatory stages. Gradual automatic thesaurus compilation is envisaged in the said model alongside with initial data accumulation in the memory and following semantic connection analysis carried out while addressing and correcting the inquiry. Solution of this problem appears to be no less important than providing the usur with direct access to the data bank.

Other possibilities of the museum computer

Utilization of the computer as an automated museum catalogue storage facility is far from covering the entire spectrum of computer applications in raising the efficacy and quality of other efforts undertaken by arts and historical museums, such as restoration research effort. For instance, improvement of picture contrast in infra- and X-ray examination represents a field of computer application likely to bring about new findings affecting painting attribution and art studies.

Roentgenostructural and spectral analysis of museum exhibits (pigments among them) is yet another example. Here, still, the specialist's handwork and intuition prevail in processing of results inevitably winding up with extremely low productivity. Automatic decoding of various spectra is the computer's direct concern.

Bearing in mind the specific objective of this Conference we do not dwell on such museum applications of the computer as automatic air conditioning, signalling and lighting control; control and formation of optimum flows of visitors; analysis of sociological research data, etc.

Conclusion

Rare practical handling of museum computer networks and data bases recently built in the United States, France and other countries is apparently due to low regard for peculiar features of the humanitarian user who, unlike some engineer or any natural science specialist finds it much harder to overcome the barrier of communication with the computer while the efficiency of batch processing conditions does not

compare too favourably with that of manual search to spend time and effort on mastering new and, to a certain extent alien to the museum worker skills required for communication with the computer.

The suggested model of the museum data bank seems to offer not only a way of surmounting this barrier but also a means of alleviating the work involved in data bank origination on the basis of an information language closely allied to a natural language.

While museum data retrieval using computer storage devices has already taken real shapes, [4] the problems of computer application in physical and chemical examinations of works of art as well as in many other museum undertakings are still waiting for their practical solution, although the roadblocks which must be overcome here do not outnumber those met in cataloguing and are, perhaps, even fewer.

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(4) R.Chehall. Museum Cataloguing in the Computer Age. Nashville, 1975.

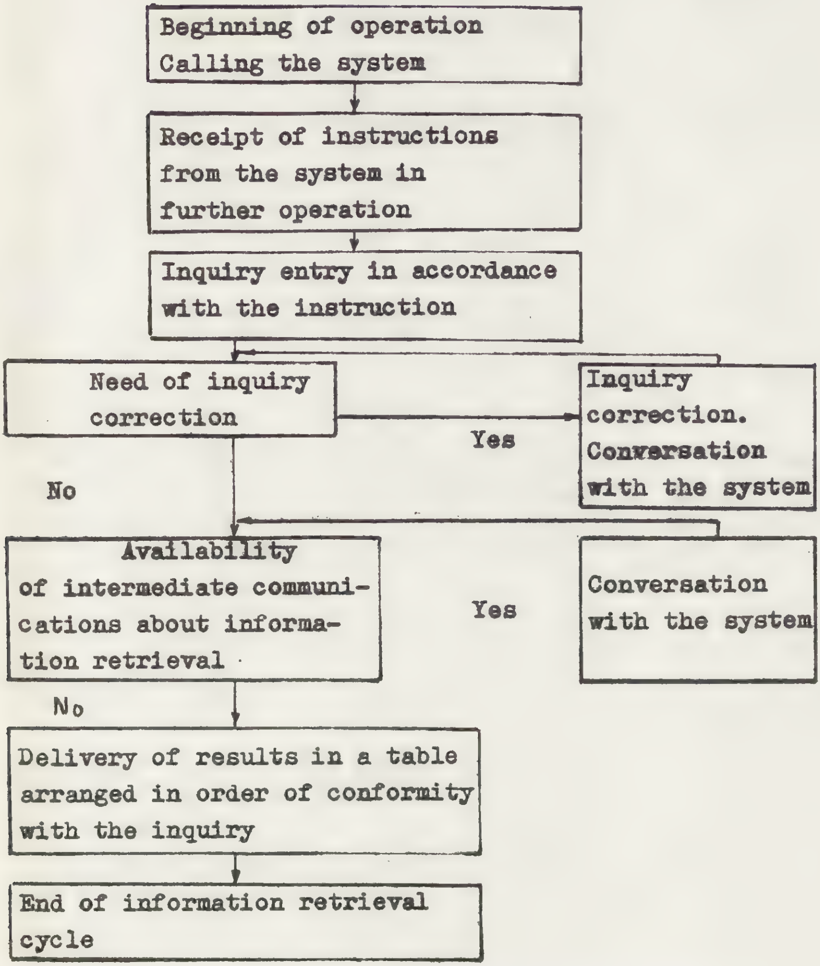

Fig. 1. Diagram of data bank model in conversational mode of operation.

LA REVELATION ET LE TRAITEMENT DES SOURCES ECRITES SUR L'HISTOIRE DE LA TECHNOLOGIE DE LA PEINTURE RUSSE ANCIENNE

Ju. Grenberg et N. Kiselev

Dans le rapport, présenté par un des auteurs à la Conférence du Comité pour la conservation à Venise (groupe de travail "Documentation") les suggestions ont été formulées quant à l'utilisation des cartes perforées pour le rassemblement, la systématisation et le traitement des renseignements des sources écrites historiques (inédites, en premier lieu) contenant les données sur les matériaux et les techniques de la peinture [1]. Il a été supposé que ce travail serait une étape préparatoire pour le traitement ultérieur du contenu de ces sources, c'est à dire pour l'introduction de tous les renseignements qui s'y trouvent dans le système information- recherche afin de l'utiliser ultérieurement.

Conformement au programme mis au point dans le rapport mentionné ci-dessus, nous avons commencé le rassemblement et le traitement des sources manuscrites portant sur les travaux des peintres russes anciens jusqu'à la limite des XVII-XVIII siècles.

L'objectif à atteindre des travaux planifiés pour plusieurs années devrait être une analyse critique des textes, qui en confrontation avec les études de laboratoire en cours des oeuvres elles-mêmes permettrait

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1. Ju.Grenberg. "Emploi des cartes perforées pour le rassemblement et le traitement des renseignements de sources écrites anciennes sur la technique et les matériaux de la peinture". Venise, 1975. 75/7/3.

d'obtenir une notion autentique sur les propriétés technologiques de la peinture russe ancienne (de chevalet et en détrempe) dans son développement historique.

L'étude par la science russe des sources écrites contenant des informations du caractère technique et technologique a débuté au milieu du siècle passé et était liée aux noms de D.A.Rovinsky, P.Ia.Agguéev, D.A.Grigorov, P.K.Simoni et d'autres hommes de science, qui ont publié au total 40 manuscripts environ des XV-XVIII siècles avec des recettes pour la peinture murale et la peinture d'icônes.

Il est difficile de surestimer l'importance de ces travaux. Cependant, le volume du matériel publié alors est manifestement insuffisant pour en tirer des conclusions généralisantes, car une partie plus importante encore de ces sources est échappée à l'attention des auteurs mentionnés ci-dessus. Il s'est avéré en outre que tout un nombre de publications n'est pas complet: il y a des coupures, des inexactitudes, des transformations des textes d'origine. En ce qui concerne l'analyse des manuscripts publiés jusqu'à nos jours, elle aussi reste insatisfaisante. De ce fait la valeur objective du matériel écrit slavo-russe, aussi bien que le degré de son originalité et de ses liens avec les traités connus sur la peinture de l'Antiquité, du Moyen âge, de la Renaissance et du Temps nouveau restent peu claires jusqu'à présent. Et enfin, il est à noter, que les textes russes anciens etant peu étudiés, leur utilisation dans la pratique contemporaine de restauration et de recherche est fort insuffisante.

Au première étape de l'étude on peut dire dans les grandes lignes du matériel existant que:

La majorité accablante de manuscripts de ce contenu se trouve en URSS et 10% environ dans les collections de la Bulgarie, de la Roumanie, de l'Yougoslavie et de l'Autriche. En général, il s'agit de différentes rédactions des manuscripts russes à partir du XV siècle mais se rapportant généralement à la fin du XVI - au début du XVIII siècle. Le matériel principal se trouve dans les manuscripts russes dits "Ikonopisnyé podlinniki". Ces instructions pour les peintres d'icônes comprennent l'icônographie des sujets et la description des formes canoniques des images de saints dans l'ordre du glossaire mensuel. Parfois elles sont complétées par des images de face, par des articles du caractère historique, théologique ou moralisateur, aussi bien que par des recettes et des instructions sur les techniques de la peinture d'icônes, de la peinture murale et des arts et métiers qui faisaient partie du champ d'activité des maîtres du Moyen âge. Le nomtre d'articles techniques dans certains recueils de "Ikonopisnyé podlinniki" varie de un ou plusieurs aux dizaines et même aux centaines de recettes.

La question sur l'origine et le temps de la composition de "Ikonopisnyé podlinniki" russe, aussi bien que de ses articles techniques n'est pas encore éclaircie. Dans le matériel manuscript slave du sud il y a des instructions sur la peinture d'icônes, analogues aux instructions russes, mais plus anciennes, dont on sait pertinement qu'elles sont les traductions des herminies grècques du type de l'ouvrage connu du début du XVIII siècle "Herminie" - du peintre d'icônes Dionissy d'Athos. Il n'est pas impossible que "Ikonopisny podlinnik" russe remonte, lui aussi, aux sources grecques disparues.

Le deuxième groupe de sources, non moins précieux,

est composé de recueils de recettes, dits "Mastérovi-ki", connus d'après les états à partir du XVI siècle. Ils comportent des dizaines et des centaines de préceptes sur la technique de la peinture, le traitement des métaux, des bois, des textiles, des os, des pierres et d'autres arts et métiers. Nous avons découvert au total une dizaine de ces manuscripts. Leur composition est similaire aux parties techniques de "Ikonopisnyé podlinnike".

Dans le troisième groupe de sources nous rapportons les manuscripts, qui ne sont pas spécialement consacrés aux arts et métiers. Premièrement, il s'agit de recueils mixtes aux sujets historiques, théologiques et de sciences naturelles. C'est précisément dans ce type de livres que se trouvent les tous premiers renseignements conservés au point de vue chronologique, se rapportant au XV siècle, sur les matériaux de la peinture. Deuxièmement, à ce groupe se rapportent les livres dits "Létchebniki". Comme on sait, les "Létchebniki" russes des XVI-XVIII siècles sont les traductions du latin, de l'allemand et du polonais. De ce fait, ils nous permettent de parler à juste titre des contacts de la peinture russe avec celle de l'Europe occidentale sur la base technologique. A partir de la fin du XVII - début XVIII siècle en Russie on procède à la traduction de l'allemand et du hollandais de différents traités et manuels sur l'industrie minière. Dans ces ouvrages les maîtres russes ont aussi puisé des renseignements sur la composition des couleurs et le traitement des matériaux, utilisés dans la peinture.

Le quatrième groupe de sources est le plus nombreux et le plus varié quant à sa composition. Bien qu'il est composé de manuscripts fort anciens - des XVIII-XIX siècles (livres de ménage, dans lesquels on

trouve des renseignements sur les matériaux de la peinture parmi les recettes culinaires, vétérinaires, médicaux et cosmétiques) et qui sont de plus les traductions en règle générale des publications imprimées allemandes et françaises, ces renseignements doivent tout de même être étudiés, car une partie de ce matériel remonte, à ce qu'il paraît, à la tradition ancienne. De plus, en général, il refletent probablement le niveau de la technologie des étapes postérieures du développement de la peinture d'icônes russe.

I'examen systématique de visu des collections manuscriptes slavo-russes de l'URSS et l'étude des descriptions des collections étrangères nous ont permis de révéler à ce jour au total 150 manuscripts environ avec le matériel du caractère technique.

Actuellement ils sont rassemblés sous forme de photocopies, on procède à leur systématisation, datation et redatation à la base de l'étude de la paléographie, du type de papier et d'autres indices.

Tous le matériel rassemblé, comme il a été dit plus haut, est enrégistré sur les cartes à perforation latérale. Ce fichier perforé - "Corps des sources écrites sur l'histoire de technologie et de technique de la peinture russe ancienne et des arts et métiers" est appelé à répondre aux questions du caractère archéographiques et de sources d'origine, telles que le titre, le temps et le lieu de création du manuscript, les traits caractéristiques de la langue, le nombre et la nomenclature d'articles techniques, se trouvant dans le manuscript. Le deuxième et l'essentiel fichier perforé donnera naissance au "Corps des recettes de la peinture russe ancienne d'après les données écrites".

La création des ouvrages généralisés sur l'histoire de la technologie des peintures russes anciennes

sur la base des données empiriques, obtenues au cours des recherches de laboratoire, dépend avant tout du volume statistiquement assuré des oeuvres étudiés par périodes, écoles, maîtres. Il nous semble que dans son ensemble c'est une affaire de l'avenir relativement lointain, tandis que la réalisation du sycle complet de l'étude des sources écrites - le rassemblement et la création du corps de tout le matériel écrit, sa classification, périodisation historique et l'interprétation scièntifique et technique contemporain sont possibles déjà dans l'avenir le plus proche.

THE COMPUTERISATION OF CONSERVATION RECORDS

R.M. Organ

The Conservation Analytical Laboratory of the Smithsonian Institution serves as a central laboratory concerned with the study and care of museum artifacts. It provides information and advice, analysis and treatment of objects, at the request of any of the many bureaux of the Institution. Seventy-nine sources of requests have been identified. The variety of objects worked on is considerable, being artistic, archaeological, historical, technological, decorative, etc, in nature. In addition, commercial products are examined to discover whether they are likely to be safe for use in prolonged contact or proximity to museum objects - in display cases, as adhesives, as envelopes for storage, etc. Analytical studies are made of groups of objects or materials of known provenance in order to extend our knowledge.

The work done is documented for a variety of reasons. Among these are the following: a) Administrative. For example: How much service has been given to each museum or bureau? Which staff members were involved in preparation for a particular exhibition and how much work did each do? (Awards were based on this information) b) Ethical. The Code of Ethics of the American Institute for Conservation requires adequate examination and recording of the condition (alteration and deterioration) of an object and a record of its treatment, revealing in detail the materials and methods of procedure employed[1/] c) Practical. A conservator may need to discover what procedures were found practicable, and others that were not, for the treatment of, for example, a rusting tin-plate heraldic shield, or the identity of the polymer(s) in a commercial varnish, or a method suitable for filling losses in a wooden mask that is to be exposed to varying relative humidities. If answers to such questions that arise in everyday tasks can be obtained quickly, and if the answers are based on work that has actually been done in the laboratory and shown to be practicable, then treat-

ment can be greatly expedited. Furthermore, documents that are reliably available for consultation can confer stability on a North American situation where conservators change jobs frequently, removing memories of past happenings with them.

Since the questions that need to be asked of these documents cannot all be foreseen, the usual small group of standard card-indexes to them cannot be designed to work satisfactorily. Instead, an optical-coincidence feature-card system comparable to those described by Kuhn[2] and Oddy[3] has been in use since 1968 and has proved very useful because: it is always up to date; it can be expanded as needed; every term in use satisfies a proved need, rather than some predetermined philosophy of indexing.

This 'Termatrex' system is the precursor of the computerised system to be described so a description of it will serve as an introduction. In order to enter a report into this index the report is first coded by its writer. He has a standard form available, containing spaces for particulars of the object treated or of the material analysed, Fig 1. On this form he selects and marks off the descriptors desired. Each of thse has a code already printed beneath it. Other necessary descriptors, such as the name of the object, the nature of its material and of the decoration on it, he finds from prepared lists, C, D, or E, and inserts together with their associated codes. If he has a new descriptor, not hitherto used, he asks for a new code to be assigned to it.

The code consists of the color (there are ten colors, SD = sand, GY = grey, etc) plus a number (00 to 99) of a card. Each card represents a single descriptor or feature or key-word and contains spaces for 100 x 100 holes. A wooden box decorated with veneer would therefore be coded as "box" (BE 42 from List C) plus "wood" (RD 66, List D) plus "veneer" (RD64 from List E). If the report number were CAL 1234, then to enter this report in the Termatrex, cards BE 42, RD66, and RD 64 would be selected, would be stacked together in register under a drill, and at the position 12 units up and 34 units along, a hole would be drilled through all three.

The same process is used to code and to record the various analyses and treatments that are actually applied to an object. The descriptors used for examinations can be relatively few and are printed directly on the standard form. The number of treatments used steadily increases. About 170 steps have been identified to date and appear in List F. In practice, between fifteen and forty cards (descriptors) are needed to index a report of anything from one to forty pages in length.

SELECTION OF KEYWORDS CAL NO ____________

FROM: Dept. (and Code,List A)________________( ) or

(underline): Govt.Dept.; museum or Nat. Trust; university; public.
(SD20) (SD21) (SD22) (SD23)

PERIOD: (circle): not stated; B.C.;A.D.;______thousands;______hundreds.
(GY07) (GY08)(GY09) (GY0) (GY1)

CULTURE: (list B)__________________________________( )

OBJECT: Noun, selected from preferred list C____________________( )

Material, selected from preferred list D____________________( )

Decoration, selected from list E: None or____________________( ).
(YW60)( )

____
( )

Add material and decoration discovered to be more correct

____
( )

REQUEST: Underline one or more of: Exam, Anal, Treat, Advice.
(GY20)(GY21)(GY22) (GY23)

Obtain above data from requisition aided by visual examination.

If entries appear here, circle codes shown:

GY20

RESULT: (underline) (exam) Photo; Phys (e.g. hardness),Radiog; Vis; Exposure or; TLD or Fig. (GY82)(R.I.,pH,etc);(GY83) (GY84) ageing(SD31)(PU37) (GY81)

GY21

Anal M. (micro,spot); Anal W (wet); Anal IR: Spectro; XR Diffn:
(GY85) (GY86) (GY87) (GY88) (GY89)
XRFluor: Neut.Activ.; (Section or metallogy); Other; A Prepr.
(GY90) (GY91) (GY92) (GY63) (RD30)

GY22 or GY23

Treatment or advice, principal steps: Verb plus codes for each step, selected from preferred list F.

____
( )

____
( )

Suspense or Referred. Tested: Satisfactory/Unsatisfactory for use on museum ob
(SD93) (GY93) (BE03) (BE05)

COMPLETION: FY________________________
(GY64 to GY80)

WORKER(s) INITIALS							
CODE							
Person-hours							

enter on yello

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LIST C - NOUNS, page 5

Crucible	GN80
Crucifix (use Cross)	BE72
Cuff-link	BE74
Cup (use Beaker)	BE33
Cup-plate (use Saucer)	PU22
Currency (use Note)	GN22
Damascus Blade	BE89
Dagger	BE75
Daguerrotype (use Photo)	GN33
Decal (use Label)	GN07
Decoration	GN88
Desiccator	RD39
Desk, secretary	PU56
Dial	GN71
Die or Seal	BE22
Dime	BE76
Dish	BE77
Document	BE78
Doll	BE79
Door, Gateway	BE80
Drawer (use Furniture)	GN01
Drawing	BE81
Dress (use Gown)	BE94
Dress, military	RD53
Dresser	PU93
Drilling, Core (use Sample)	GN48
Drum	SD06
Dust (use also Unknown if applicable)	SD52
Duster	WH72
Dyestuff	BE82

LIST D - MAJOR MATERIAL, page 3

Marble (try also YW27 and YW56)	WH37
Masonite, use Wood	YW50
Metal, other, including Aluminum	YW25
Metal, unspecified	YW26
Minerals and Gemstones	YW27
Mother of Pearl (use Shell)	YW42
Mylar = Polyester	RD68
Natural products, e.g. Fats, Lanoline, Steroid	RD75
Nickel and Alloys	YW28
Nylon = Polyamide	PU27
Oil, of painting	YW29
Paint	GN25
Paper mache	WH36
Paper; card (See also Treated Paper - SD76)	YW30
Paper, parchmentised	YW30
Parchment, Vellum	YW31
Parting agent (see Wax)	YW48
Pastel	YW32
Pearl	BK02
Pelt	YW 14
Pencil	YW33
Pewter (see Tin Alloy YW46, Lead Alloy YW22)	YW46
Pigment (also look at GN34 and color for early CAL numbers only)	YW35
Plaster, or ground of painting	YW36
Plastics (incl. spray) or Resin, synthetic	YW37
Polish (use Chemical)	YW09
Polyester resin	RD68
Polyethylene	RD76
Polystyrene	YW37
Polyvinyl acetate, synthetic	RD72
Polyvinyl chloride, synthetic	RD71

LIST E DECORATION OR MINOR MATERIAL

None	YW60
Abuse	PU11
Accretions, fixed (cf. 'applique')	RD17
Accretions, loose (cf. 'applique')	SD57
Adhesive substance (sticky)	SD70
Altered in appearance by Man, not restoration	RD63
Applique (anything deliberately attached to surface by humans)	YW61
Bitumen (use Pitch)	PU44
Bleached appearance	BK05
Bloom, discoloration of or on surface only	YW73
Blued steel (deliberate)	RD94
Board (support)	PU10
Brass	RD96
Bone or Ivory	RD98
Braid	WH81
Brittle condition	PU14
Burned	SD28
Calcareous crust	RD12
Cadmium plating	PU64
Caning	WH95
Cast decoration, inscription	WH08
Cloth or textile material	RD21
Coating on paper, synthetic	SD27
Cockled puckered	WH58
Color: loose pigment only (without binder): not dye, nor stain nor pastel nor printed on. Specify color (see Colors, Descriptive)	SD56
COLORS, Descriptive	
Black	RD08
Blue	RD02
Brown, tan	RD07
Green	RD03
Grey	RD10
Indigo	RD01
Metallic	RD11
Orange	RD05
Red	RD06
Violet	RD00

LIST F - STEPS IN TREATMENT OR ADVICE: VERBS, PROCESSES, page 4

Packing for transport	YW76
Padding, stuffing for reinforcement, (removable, contrast Adding)	SD81
Paper sizing	YW75
Patching, repairing tears	YW99
Picking, flicking (shearing), as to flyspecks, Corrosion products, etc.	WH20
Planing	RD34
Polishing, Burnishing or Smearing	SD62
Potassium Lactate treatment	RD60
Poultice	SD60
Pressing, flattening, taping, clamping	SD51
Rasping wood	RD89
Reduction, not electrolysis (e.g. borohydride, etc.)	RD16
Reforming, e.g. Varnish	RD48
Regular observation (periodical)	YW84
Reinforceing (backing, facing, laminating) by use of adhesive	YW96
Reinforcement with "Buffered" backing	RD90
Removing additions (e.g. adhesive tape or dry mount or paint or screws applied pre-CAL	YW97
Removing dust	WH45
Removing stains, discolored varnish on paper, paintings, etc., i.e. localized superficial washing	YW98
Removing stains by poultice e.g. Goddards	SD60
Repairing, patching tears	YW99
Repatination, wood staining	YW74
Replacement of components	RD29
Reproduction	BE07
Rivetting	PU79
Rolling into leather	PU28
Sampling for analysis	RD28
Sanding ——— YW87	
Sawing (hand or machine)	RD45
Scraping (scraper, dull knife)	RD92

In order to recover any particular report from the file, as many descriptors as together describe it are assembled and the corresponding drilled cards are taken from their storage rack and stacked upon a light-box. Then light appears through only a few holes.. These are decoded by their coordinates as, for example, 4321, 2507, 0123, and represent the reports which contain the information desired.

This system enables administrative questions to be answered fairly easily and also allows conservators to locate reports that describe treatments applied earlier to objects now facing them for the first time. Whether the search proves helpful depends on how complete the original report was made. This subject is addressed by the Code of Ethics and has been discussed elsewhere by the present author4/. If the coding and drilling is done by the conservators themselves then they learn for themselves the various quirks that the system may have and they become able to direct searches to the greatest advantage.

The weaknesses of the Termatrex are that: it can only accept 10,000 reports and 1000 descriptors without becoming over-complex; and the descriptors (keywords) have to be made wide in meaning in order to catch all of the reports that might be helpful during a search. At present there are approaching 3000 reports in the file and over 900 descriptors in use, many of them serving multiple purposes.

The computer system utilises experience gained with the Termatrex and is operating in parallel with it until it has been proved to be equally reliable. It is not operated by conservators, however. An Information Officer takes a completed and coded report and abstracts it on to a standard form, Fig 2, using words, not codes, in the various categories. Then he keys the data into a computer terminal. The categories correspond with divisions in the Termatrex coding sheet. There are now no limitations on the number of words that can be selected as descriptors but in fact an agreed thesaurus must be used since the computer will consider "hair, horse" to be different from "horsehair" and a search for reports concerning horsehair would not find any that contained the alternative form. To the computer, even "exam" can be different from "examination"

A few comments on the nature of the categories shown in Fig 2 may prove helpful, as follows. The C.A.L. Number is a serial number unique to each report and used to identify also the photographs and charts associated with it. The 'object name' is the descriptor used by the curator or other person who submits the request. 'Catalog Number' is a number by which the museum owning the object

C.A.L. No. 000 00____00
Object Name 010
Catalog No. 015
Period 020
Culture 030
Suspense 040
Referred 050
Source 060
Person Hours 070
Objectives 080
FY Completed 090
Con/Sci 091
000 00
Material 110
Product Name 115
Manufacturer 116
Calendar Yr. 117
Decoration 120
Condition 130
Restrictions 140
000 00
Treat/Anal 160
Formulas 165
Bibliography 166
Narrative 170

Fig 2

SERIAL NO 00176300 10/31/77
160 01 CONDITIONING; CONSOLIDATION; DRESSING
170 01 THE FENDERS, STIRRUP LEATHERS AND TAPADEROS HAVE
02 SURFACES WHICH SHED PARTICLES WHEN LIGHTLY RUBBED
03 WAS BRUSHED WITH ALCOHOLIC POTASSIUM LACTATE (ONE
04 SOLUTION OF POTASSIUM LACTATE IN NINE VOLUMES OF
05 FRIABLE AREAS WERE CONSOLIDATED WITH FLEXBOND (PV
06 IN ACETONE. STIFFNESS WAS LESSENED BY PAINTING
07 WITH BAVON ASAK-ABP LEATHER DRESSING IN HEXANE.
NEXT RECORD?

Fig 3

can identify it: it may be an accession number or loan number. 'Period' is usually the century, A.D.or B.C., to which the origin of the object or sample has been assigned. 'Culture' is, for example, Sasanian or Modern American or Greek or . . 'Suspense' is used to identify reports which have been completed and logged out of the laboratory but which contain incompletely-solved problems or currently unanswerable questions which can become subjects for further research. 'Referred' describes requests which have been considered then referred to a private conservator or elsewhere because, for example, C.A.L is not equipped to do the work or cannot complete it in the prescribed time because of staff shortage or otherwise. 'Person-hours' is the total number of hours spent on the request by all staff involved. 'Objectives' for the work reported match one or more of the laid-down functions of the laboratory, for example, examination, analysis, treatment. 'FY' signifies the Fiscal Year of completion (some requests occupy several years). 'Con/Sci' is a list ofthe names of all, conservator and scientist, who contribute to the final report. 'Material' is the principal substance of the object, for example, wood, or steel. 'Product Name' is that used by the seller of a commercial formula, for example, Bon Ami, Permalife, Silver Dip, Carbowax, etc. 'Calendar Year' refers to the date of purchase or production of a commercial product, necessary because formulas may change but the name remain the same. 'Decoration' is the secondary material(s) of the object, for example, ivory inlay, or corrosion crusts or accretions. 'Condition' indicates for the various materials: their physical state, for example, torn, cracked, lost; or their chemical alteration, such as tarnished, corroded, bleached, faded, etc. 'Restrictions' concerns curatorial limitations placed on the work, such as: treatment to be completed within two weeks; no change in appearance; to be prepared for a travelling exhibition. 'Treat/Anal' is a list of the names of procedures used in treatment or analysis of the object. 'Formulas' lists the names of reagents or solvents used. References to photographs or drawings are inserted wherever they belong, say, in categories 120, 130, 160, 165, 170, etc.

When there are many materials present in a complex object, in order to associate one kind of material (either principal or secondary) with its own condition and treatment, categories 110 to 165 are written out separately for each material that appears in 110 or 120, so that for each of them we read: what it was, its condition, what was done to it, and (from the rest of the report) why it was done in this particular way.

Next comes 'Bibliography', satisfied by 'Yes' if the report contains a list of references consulted and assessed in the course of deciding on particular procedures.

Finally, the Narrative consists of a concise but complete abstract of the entire report, sixty-four characters to a line.

It will be recognised that the categories described above are of two kinds: from 0 to 166 there is a series of flags by which the nature of the report can be identified readily; category 170 is a narrative abstract by which the degree of relevance of the report to some particular current enquiry can be estimated without reading the entire text. If then, one needs to know only how many requests from bureau A during Fiscal Year 1972 concerned analyses of Modern American cups, then the computer need only scan category 060 for 'A', 090 for '1972', 080 for 'analysis', 030 for 'Modern American' and 010 for 'cup'. It can then count up all the reports that include these five descriptors and return the required answer. This operation is rapid because the computer only searches the places in the record where the answers are to be found, ignoring all others. Equally, if the details of these same reports are of interest, then the computer will stop at each successful 'hit' and will present the corresponding abstract on a screen to be read and then printed out if of sufficient interest. After preliminary review, the person requesting the search can consult the full reports, outside the computer file, for the details that interest him. If the flags were not separately identified in this way the computer would be required to search through the entire series of abstracts in the record every time a question was presented to it - an intolerably slow process requiring minutes instead of seconds.

For each report that he abstracts, the Information Officer keys the data, sorted into categories as above, into an 'Entrex' terminal, seeing on its screen the words that he types so that keying errors can be corrected. This record is stored for a time on a disc in the order in which it was presented. Individual records can be called back on to the screen provided that the number of the report is known. At intervals, the record (the file) that has accumulated can be cleaned up through various programs which, for example, identify misspellings, indicate reports for which expected categories have not been entered, indicate words which do not appear in an accepted Thesaurus. Corrections can then be made by use of punched cards, one for each line of the file to be corrected. Next, this file is merged with the existing Master File tape to create a new larger Master File.

From the Master File, various programs can produce indexes, lists of frequency of occurrence of various descriptors, etc, but the most valuable product is a Query File. This is an inverted file, the most recent reports first, loaded on to a disc so that it can be interrogated from the Information Officer's Hazeltine 2000 terminal

which, like the Entrex terminal, is linked to the distant computer by dedicated telephone lines.

Fig 3 shows one abstract out of twenty-two produced in answer to a request for methods of dressing and conditioning leather. Rapid retrieval of relevant abstracts, pointing to fully detailed reports, is expected to expedite work in progress on a wide variety of objects and to raise the intellectual content of successive reports on similar problems.

The computer program that makes this procedure possible is SELGEM (SELf-GEnerating Master) developed by the staff of the Office of Computer Services, Smithsonian Institution. It is a "generalised system for information storage, management, and retrieval . . . that offers the ability to adjust a record's length, content, and format on a spontaneous basis and accomodates unanticipated data without reprogramming . . . A large capital investment is unnecessary.

SELGEM provides a generalised method to search, and to print selected outputs, and it also provides generalised routines for such functions as storage, update, sort, report writing, editing, thesaurus processing, as well as for bibliographic and collection indexing. The system is operated in batch-processing mode with the retrieval program accessible by remote terminal . . . It is written entirely in COBOL language, making it highly equipment-independent. It can be installed by journeyman programmers on any computer with four tape units, a COBOL language compiler, and 96,000 characters of main storage"

Details of the program are available to potential users from the Office of Computer Services, Smithsonian Institution.

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3) Oddy, W.A. and Barker, H. A Feature Card Information-Retrieval System for the General Museum Laboratory. Studies in Conservation, <u>16</u>, 3 (1971) 89-94.

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5) Creighton, R., Packard, P., and Linn, H. Selgem Retrieval: A General Description. In: Cuadernos de Historia Economica de Cataluna, IX, Barcelona, June 1973.
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Klausen, I. SELGEM: Et Automatisert Informasjonssystem Universitetet i Trondheim, 1974, Det Kgl. Norske Videnskabers Selskab, Museet Erling Skakkesgt 47b, N-7000 Tronheim, Norway.

ATTEMPTS TO THE ELABORATION OF A STANDARD AND UP-TO-DATE CONSERVATION DOCUMENTATION SYSTEM FOR HUNGARIAN MUSEUMS

Tamás Kiss

ABSTRACT

A draft of a standard, computer-compatible conservation documentation system is introduced. Brief summary is given of the structure of a record-book and recording card submitted for application in Hungarian Museums, with the reproduction of the card.

INTRODUCTION

The activities in the field of conservation have become rather complex nowadays. This process is influenced by more factors, the most significant being the fact that the connections with the branches of natural sciences are increasingly tight; conservation work became a science rather than artistic work, moreover, an interdisciplinary science. This caused the accumulation of information in a respectable quantity. Utilization of new materials and methods is more and more intensive, modern education requires the use of a wide-spread reference-material. Tighter contacts between curators and restorers provide the opportunity of mutual exchange of information. These factors encourage the introduction of a modern conservation documentation system.

Detailed report of conservation work could be compared to a hospital closing report - there is no doubt about the signification of the latter in the further treatment of the patient.On the other hand, conservation documentation is a primary source of information /1/.

As it was also stated at the Venice Meeting, conservation documentation is tightly connected with the application of an appropriately high speed and great capacity information storage and retrieval system.

In Hungary a unified system of museum registration /inventory numbers, size of the register-books and inventory cards, way of storage, etc./ has been introduced since the early fifties. The need for a precise conservation documentation system was also expressed that time /2/. Its employment was formally imposed in 1965 /3/. This instruction recommended a double form of documentation, grounded on the inventory system: a record-book for every object treated, and files for the detailed recording of the conservation methods and materials by museum objects of greater significance. Sizes are identical with that of the register-book and the inventory

card: 263x380 mm and 148x210 mm /A5/, respectively.

We focused our attempts on the further elaboration /design, items, information storage and retrieval system/. I must emphasize, that we are only at the first steps yet, so this draft is actually "a pudding before being eaten".

DESCRIPTION OF THE SYSTEM

1., The record-book

Type used in the Hungarian National Museum was accepted. Rubrics: serial number, inv. number /or temporary indication/, name and type of the object, materials, number of pieces, collection, registration and date of receiving, condition before treatment, methods and materials used, serial number of the recording card /if such a card was filled out/, restorer, registration and date of delivering, remarks.

2., The recording card /see illustration/

We tried to get acquainted with the efforts made abroad, first of all with the employment, advantages and lacks of punched cards. The use of edge punched cards /4,5/ must have been rejected, mainly because of cost problems and the difficulties of the central registration. Feature cards seemed to be more convenient, but they also have the disadvantage of being suitable up to a max. of 10 000 records only /6,7/. The only optimal solution is the use of a computerized system. /Needless to particularize here the problems of choosing an appropriate information-processing system, many publications have come out on this subject recently /8/.

After the comparison of these experiences we chose a system which can be registrated by feature cards and by a computerized retrieval system respectively - so each museum could use a feature card system indoor, but every information could be registrated by a central data-bank if needed.

This form of the card and the book are designed particularly for use in general museums, special documentation system is under preparation for art objects /sculptures, paintings, murals, etc./.

Each card has an A4 format. The storage size is corresponding to A5, since the cards are designed to insert appendices /see below/ after folding.

The card consists of 5 parts by structure: identification, tests, condition before treatment, steps of treatment and a space for remarks and advices concerning future storage conditions.

001. Identification

- more points of this section are connected with the great

task of the elaboration of a general, centralised museum documentation system /items 01, 02, 06, 09, 10, 11, 12, 14, 15, 16/. There are some results in this field in our country /9/.

Categories: 01. museum /9 digit identity number, hence abbreviated IN
02. collection /2 digit IN/
03. restorer /3 digit IN/
04. serial number from the record-book /brief summary of each file is recorded there too/
05. serial number of the card, e.g. 78/396
06. inv. number of the object treated
07. treatment began
08. treatment completed
09. type of the object
10. materials of the object
11. place of origin
12. estimated date before treatment
13. accidental correction after restoration /at these two items o means BC., 1 means AD, and there are two further digits for the century/
14., 15., 16: measures of the object in cm
17. associated documents /1 if existing, o if not/
18. visual documentation /inv. numbers, 1 or o in the appropriate boxes/

002. Tests executed

two digit number by code in the boxes, description of the aims, methods and results /additional A5 cards can be used, inserted as an appendix/. Computerized systems will give many possibilities in this field also /processing of routine identifications, systematic analysis, dating methods, etc./ /10/

003. Condition before treatment

nine categories for the description /the relevant ones underlined, marked with 1 in the box, o if irrelevant/. When completed, the form indicates the degree of the safety of the environment in which the object has been stored.

004. Description of the treatment

in Hungarian terminology the total treatment of a museum object consists of four parts: cleaning, conservation, restoration and reconstruction. These categories are particularized here.

1. cleaning: a. mechanical, b. chemical, c. removal of materials applied during previous restorations or conservations, d. desinfection /appropriate underlined and marked with 1 or o in the box/

2. conservation: a. impregnation, b. coating, c. structural integration, d. sticking

3. restoration: a. completion, b. surface or paint layer restoration, c. removal of repaints, d. restoration of distortions

4. reconstruction: means the completion of a totally disintegrated or highly incomplete object. Sources of the work, conception and the uncertainty factors are recorded here. Registration: 1 or o in the box.

The registration system gives the opportunity of making a survey of the conservation activity in general museums.

The last section is reserved for a brief summary and for the recording of advice concerning storage and exhibition conditions after treatment.

Registration of chemicals and treatments used is also in our plans /this would be very useful in case of an intervention which proved to be dangerous in the meantime/. Chemicals can be registrated with the help of our list of chemicals /11/. Publication of a textbook for conservators is under preparation. Here the different types of the treatments will be provided with identification numbers, too.

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7. W.A. Oddy and H. Barker, "A Feature Card Information-retrieval System for the General Museum Laboratory", Studies in Conservation 16. pp. 89-94. /1971/

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10. A.E. Werner and A.J. Hall, "Computer Facilities in British Museum Research Laboratory", Bulletin Inst. Roy. du Patrimoine Artistique, Misc. in Memoriam Paul Coremans 15. pp. 405-411 /1975/

11. "A muzeumi mütárgyvédelemben használatos vegyszerek jegyzéke" /List of Chemicals Used in the Conservation of Museum Objects/, published by the Institute of Conservation and Methodology of Museums, Budapest, /1976/

Front page of the folded card

001 IDENTIFICATION

01 museum	03 restorer	05 card N°
02 collection	04 book N°	06 inv. N°
		treatm. 07 began
		08 compl.

09 object type	10 material(s)	11 origin
		date 12 13
		14 15 16

photos add.cards drawings control technology reports other............17

18 visual docum.

norm. slide UV

color X-ray IR

002 TESTS EXECUTED

test type

aims, methods	results

Back page of the folded card

003 CONDITION BEFORE TREATMENT

a. former conserv. and restor.

b. climatological damages

c. stains

d. insects, micro-organizms, fungi

e. missing parts, lacunae

f. distortions, decomposition

g. tears, flaking

h. structural alterations

i. discoloration

a. b. c. d. e. f. g. h. i.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Inner part of the folded card /1/

004 DESCRIPTION OF TREATMENT

1. CLEANING: a. mechanical b. chemical c. rem.of mat. d. desinf.

a b c d

treatm. chem.

2. CONSERVATION: a. impregn. b. coating c. struct.integr. d. sticking

a b c d

treatm. chem.

Inner part of the folded card /2/

004 DESCRIPTION OF TREATMENT

3. RESTORATION: a. completion b. surf. or paint layer restoration
c. removal of repaints d. rest. of distortions

a b c d

treatm. chem.

4. RECONSTRUCTION:

SUMMARY, ADVICED STORAGE CONDITIONS:

ETABLISSEMENT D'UN CLASSEMENT THEMATIQUE DE LA DOCUMENTATION ECRITE ET PHOTOGRAPHIQUE AU SERVICE DE RESTAURATION DES PEINTURES DES MUSEES NATIONAUX

E. Pacoud-Rème, S. Bergeon, C. Mathieu, C. Félix et F. Canet

Résumé :Le classement thematique de la documentation mis au point au Service de la Restauration des Peintures des Musées Nationaux couvre un domaine bien délimité: celui de la technologie et de la restauration des peintures de chevalet.

La volonté de classement a abouti à un thesaurus théma-tique à représentation fléchée dont l'essentiel concerne le domaine précisé ci-dessus. L'intégration de la documentation photographique a rendu obligatoire un raffinement poussé de certains aspects de la matière.

Ce travail peut-être considéré comme une étape préliminaire à l'automatisation.

L'objectif était une réorganisation complète de la documentation. Il existait un fichier "Matières" difficile à manipuler pour la documentation écrite et parallèlement plusieurs fichiers, incomplets et trop diversifiés pour une documentation photographique très importante.

La réorganisation a abouti à un classement de la matière "Technologie et Restauration des peintures de chevalet" couvrant à la fois la documentation écrite et photographique. Nous reviendrons sur cet aspect spécifique du classement.

I - Etablissement du plan de classement

Avant d'entreprendre ce travail, des contacts ont été pris avec différents organismes français et étrangers, concernés par ces problèmes.
Nous avons pris connaissance du plan de classement de la documentation du Centre International de Rome pour la Conservation des Biens Culturels, couvrant un domaine plus général que celui nécessaire à nos besoins.

L'Institut Royal du Patrimoine Artistique de Bruxelles nous a fait savoir qu'il n'existait pas de publication d'un plan développé du classement de sa documentation. Nous avons consulté avec profit l'article (1) de G.L.STOUT paru dans le Bulletin de l'IRPA (vol.XV.1975) dont une

version résumée(2) avait parue en 1973 dans le Bulletin de l'A.I.C. (vol XIII n°2)

Pour la France, des contacts ont été pris d'une part avec le Laboratoire de Recherche des Musées de France, d'autre part avec le Laboratoire de Recherche des Monuments Historiques, de Champs sur Marne, et l'Inventaire Général des richesses de la France. Leur choix de mots descripteurs correspondait soit à des disciplines scientifiques qui ne forment pas l'essentiel de nos activités propres, soit à un niveau de spécialisation en restauration insuffisant par rapport à notre documentation.

Nous tenons à remercier Melle LAUREILHE, Conservateur du bureau des Thesauri à la Bibliothèque Nationale, dont les conseils en matière d'établissement d'un thésaurus ont grandement facilité notre travail.

Nous avons enfin essayé de suivre les indications de la norme Z.47.100 AFNOR 1973 :"Règles d'établissements des Thésaurus en langue française.

Nous avons adopté une méthode "synthétique" pour l'élaboration d'une liste de mots descripteurs ou non, puisque nous sommes partis de listes partielles déjà existantes dans le service, du précédant fichier "Matières", des tables des matières des livres et revues spécialisées... etc

Cette liste a permis de mettre en place un thésaurus thématique à représentation fléchée, qui permet aux utilisateurs d'avoir une vision immédiate et globale des relations de hiérarchie des mots utilisés en Restauration des Peintures. Un index alphabétique, sans relations de hiérarchie, regroupe également tous ces mots, afin de faciliter les recherches. La numérotation décimale universelle a été adoptée, également pour faciliter le codage de la documentation.

Les tests effectués sur des photos et des articles de revues ont entrainé quelques modifications, en particulier dans le sens d'un plus grand raffinement du développement de la hiérarchie.

Au total, ce travail a demandé cinq mois de travail par une équipe de 4 personnes dont 3 à temps complet et une à mi-temps. Pour appliquer ce nouveau plan de classement à la documentation tant écrite que photographique, il faut compter encore environ six mois. La mise à jour suivra l'évolution des recherches en matière de restauration, mais nous ne pensons pas que des remaniements importants soient nécessaires rapidement.

II - Contenu du classement

1) Sa structure : Plan général

PLAN DE CLASSEMENT

2)-comme on peut le voir, la 1ere partie "Généralités" comprend tout d'abord différents aspects de Muséologie; y sont regroupés également tous les éléments concernant les problèmes généraux de conservation et de restauration de tous les matériaux (Pierre--Terre - Verre - Métaux - Papier - Matières organiques - Textiles - Bois - Laques - Matériaux synthétiques). Enfin, la restauration y est détaillée, en tant que discipline. Cette partie permet de classer toute la documentation générale écrite de la Bibliothèque spécialisée en restauration en dépôt au Service de la Restauration des Peintures des Musées Nationaux.

la-deuxième partie est consacrée aux Analyses scientifiques qui permettent une connaissance approfondie des Objets d'Art. On y détaille tout d'abord les méthodes, puis leurs applications aux différents matériaux, enfin leur application à la peinture de chevalet.

Les quatre parties : Support "Particuliers" de Peintures, Support Bois, Support Toile, Couche Picturale sont enfin entièrement consacrées aux problèmes de Technologie et Restauration des Peintures de chevalet. Elles sont toutes subdivisées en 3 sections : la Constitution, les Altérations et les Interventions qui y remédient. (3)

3)-Nous montrons ici, à titre d'exemple, un extrait de la 4e partie "Support Toile". Il s'agit de la 1e section: Constitution :

T. SUPPORT TOILE

C. Constitution

- TC o. Chassis
  - TC oo. Simple
  - TC o1. à clefs
  - TC o2. Métallique à ressorts
- TC 1. Textile
  - TC 1o. Nature physico-chimique & proprétés des textiles
    - TC 1oo. Lin
    - TC 1o1. Chanvre
    - TC 1o2. Autres
  - TC 11. Armures
    - TC 11o. Toile
      - TC 11oo. Lache et grosse
      - TC 11o1. Serrée et fine
    - TC 111. Sergé
      - TC 111o. Simple
      - TC 1111. Chevrons
      - TC 1112. Toile à matelas
    - TC 112. Damas
  - TC 12. Coutures
    - TC 12o. Plates
    - TC 121. Surjets
  - TC 13. Incrustations
  - TC 14. Guirlandes
  - TC 15. Revers
    - TC 15o. Encollé
    - TC 151. Enduit à la cire-résine
    - TC 152. Peint
  - TC 16. Inscriptions,cachets,étiquettes

III - <u>Caractère spécifique de ce classement</u> :

Les spécialistes de la Restauration pourront être surpris du développement de certains aspects, alors que d'autres paraissent moins approfondis. Cette différence s'explique, en fait, par l'intégration de la documentation photographique. En effet certains éléments de la technologie et de la Restauration des Peintures font par leur nature même, plus particulièrement l'objet de photographies nombreuses et détaillées. D'autres, au contraire, mettant l'accent sur l'action, peuvent difficilement être visualisés de la même façon.

Nous tenions d'autre part à exploiter la collection de clichés du Service de Restauration des Peintures des Musées Nationaux, qui comporte environ 15000 documents, "noir et blanc", plus de 8000 kodachromes... etc.

La confrontation des deux types de documentation a, une valeur pédagogique certaine. De plus, elle facilite d'éventuelles recherches ultérieures. Elle est sûrement le trait caractéristique et original de ce classement.

La mise au point de ce classement va permettre, à l'intérieur même du service, une utilisation plus aisée et plus large de la documentation. Enfin, si l'automatisation était envisagée, on peut dire que la première étape, souvent la plus difficile, serait déjà accomplie.

NOTES

1) G.L.STOUT "A provisional conspectus of conservation in the Arts" dans <u>IRPA.Bulletin</u> vol.XV, 1975 - Bruxelles p.381

2) G.L.STOUT "Trial Outline of Conservation in the Arts (summary)" dans <u>Bulletin of the American Institut For Conservation of Historic and Artistic Works</u> 1973. vol.XIII n°2 - p.30.

3) Comme on peut le voir, le bois, par exemple, est donc étudié dans le détail comme support de peinture, mais seulement de façon très générale en tant que matériau d'un objet d'Art, comme une sculpture. Il reste cependant possible, si on s'intéresse plus particulièrement à un des matériaux, de le développer dans une partie supplémentaire.

LES QUESTIONNAIRES ET LES CATALOGUES COMME MOYENS DANS LA RESTAURATION

Ivan Bogovčič

R é s u m é

La présente contribution n'est qu'une partie d'un plus ample article publié dans la revue "LA PROTECTION DES MONUMENTS" (VARSTVO SPOMENIKOV) de Ljubljana (Nos XX et XXI). Cette contribution entame deux problèmes sans cesse présents dans la restauration.
Le premier problème sont les questionnaires appropriés qui serviraient au restaurateur d'aide-mémoire dans la programmation d'une intervention dans la rédaction du rapport de travail et aussi comme fondement de la construction financière de l'intervention.
Le second problème est représenté par les catalogues des matériaux et des préparations, qui sont ou ont été utilisés dans la restauration.

LE QUESTIONNAIRE

Je me limiterai à un seul questionnaire destiné aux peintures murales et à la mosaïque. Dans le fond, tous les questionnaires pour tous les genres artistiques se ressemblent beaucoup, ils ne se distinguent que dans certains détails spécifiques.
A côté du présent questionnaire, j'ai élaboré encore un questionnaire pour les peintures sur toile, sur bois et les produits du bois, et un questionnaire pour la sculpture en bois et en pierre, publiés dans la revue citée.

La caractéristique générale du questionnaire est qu'il ne contient pas de questions sur les données de base de l'objet traité et sur les conditions dans lesquelles l'objet

existe (du moins pas toutes). Par contre, il contient tous les autres éléments essentiels qui sont importants pour l'organisation et le cours de l'intervention et, bien sûr, pour la rédaction des rapports sur l'intervention.
Le questionnaire devrait englober avant tout les techniques ordinaires et les matériaux qui se manifestent le plus souvent dans notre espace culturel (slovène). Pour les caractères spécifiques éventuels, c'est chaque spécialiste qui doit y pourvoir lui-même. En accord avec le développement de la branche et les nouvelles connaissances sur les objets des interventions, il faut élargir et compléter le questionnaire.

Le questionnaire - peintures murales, mosaîques

1- PRÉPARATIONS
   1.1- la commission professionnelle ou le collège avant l'intervention (procès-verbal)
   1.2- la documentation textuelle (brève), grafique et photo avant l'intervention
   1.3- la protection de l'objet avant le transport (morceaux détachés)
      1.3.1- les matériaux employés
      1.3.2- les moyens employés
   1.4- le transport de l'objet à l'atelier de restauration (morceaux détachés)
      1.4.1- le cours du transport
      1.4.2- particularités (assurance,...)
2- DESCRIPTION ICONOGRAPHIQUE DE L'OEUVRE
   comme moyen pour les descriptions des procédés (localisation)
3- L'ÉTAT DE L'OBJET - LES CONSTATATIONS AVANT L'INTERVENTION
   3.1- le porteur
      3.1.1- le genre de porteur: mur (en pierre, en brique, en béton, mélangé,...),...
      3.1.2- les annexes aux porteurs: soutiens et armatures, isolations, canaux, drainage, remblais

3.1.3- la qualité du porteur, les caractéristiques: solidité, liaison de la base du porteur (pierre, brique,...) avec le liant (mortier, colles,...), liaison du liant lui-même, liaison avec les éléments additionnels.

3.1.4- les endommagements: mécaniques ou chimiques (même d'origine biologique) - (grandeur, espèce, causes, localisation): craquement, effritement, démolition, brisé, broyé, détaché, brûlé, pourri, humide, pollué (déchets biologiques,...)

3.1.5- les éléments documentaires: étiquettes, notes (pièces d'exposition de musée), notes écrites ou gravées,...

3.2- les crépis

3.2.1- l'assemblage: à une, deux, plusieurs couches, combiné,...

3.2.2- le genre: crépis classiques, crépis allonges, crépis sinthétiques, combiné,...

3.2.3- la composition de l'enduit

3.2.3.1- le liant: chaux (éteinte, vive), ciments, matériaux synthétiques,...

3.2.3.2- le matériau de remplissage: sable, les produits préfabriques sableux (roches expansées et argiles,...),..

3.2.3.3- les suppléments hydrauliques: brique moulue, lave volcanique (moulue),...

3.2.3.4- l'armature: fibres d'origine biologique, fibres d'origine synthétique, grillages métalliques, éclats de bois, paille, balle,...

3.2.4- les annexes (pour les peintures de montage et les mosaîques): cadres porteurs (sous-cadres), cadres extérieures, (décoratifs ou protecteurs), armatures extérieures, moyen de montage,...

3.2.5- la qualité des crépis: solidité, liaison des couches, elasticité, liaison avec le porteur, liaison avec la couche de couleur ou avec les cubes (mosaîque)

3.2.6- les endommagements: mécaniques ou chimiques (même d'origine biologique) - (grandeur, espèce, causes, localisation): fendillement, pelage par couches, s'effrite, fait de la poussière, sous-bulleux, lavé, égratigné, brûlé, pourri, humide, pollué (déchets biologiques,...)

3.2.7- les caractères spécifiques des crépis: parties imprimées, gravures, synopies, indemnités quotidiennes

3.2.8- les interventions postérieures: plomb, points de suture, ouvertures (séchage, ventilation,...), gravures,...

3.3- la couche de couleur, les cubes .

3.3.1- l'assemblage: à une, deux, plusieurs couches

3.3.2- la technique: fresco buono, secco, mixte, huile, caséine, colle forte, oeuf, acrilique, pour la mosaîque: pierre (marbre, calcaire,.,), brique, colorant bleu, verre, pièces métalliques insérées, pierres précieuses et semi-précieuses,...

3.3.3- le traitement: glacis, pâteux, couches de fond, pentiments, en relief (pour la mosaîque et certaines peintures murales)

3.3.4- la composition de la couche de la couleur

3.3.4.1- le liant: chaux, caséine, colle forte oeuf, huile, cire,
pour la mosaîque, du mortier dans les joints entre les cubes (calcaire, allongé, cimenté, à base de colles synthétiques)

3.3.4.2- le matériau de replissage: spath pesant, lithopones, cendres, sable,...

3.3.4.3- les pigments

3.3.4.3.1- l'origine: inorganique, organique

3.3.4.3.2- la formation: naturelle, artificielle

3.3.4.3.3- le genre: nom du pigment pour la mosaïque: la couleur du matériau dont sont faits les cubes

3.3.5- la qualité de la couche de couleur: liaison (cohésion), liaison avec les enduits et la couche de protection (adhésion), élasticité, stabilité, pour la mosaïque solidité des cubes et du crépi liant, liaison réciproque

3.3.6- les endommagements de la couche de couleur: mécaniques ou chimiques (même d'origine biologique) - (grandeur, espèce, causes, localisation): fendillé, pelage par couches, s'effrite, fait de la poussière, bulleux, lavé, brûlé, calciné, humide, pollué (déchets biologiques)

3.3.7- la spécificité de la couche de couleur: pièces insérées, traitement en surface, dorures,...

3.3.8- les interventions postérieures sur la couche de couleur: retouches, repeints, mastics, badigeons, couches de protection postérieures, notations (gravures,...)

3.4- la couche de protection

3.4.1- l'assemblage: à une, plusieures couches

3.4.2- la composition: caséine, oeuf, cire, résines (naturelles et synthétiques)

3.4.3- la qualité de la couche de protection: liaison (cohésion), solidité, élasticité, transparence, liaison avec la couche de couleur (adhésion, réversibilité

3.4.4- les endommagements: mécaniques et chimiques (même d'origine biologiques).- (grandeur, genre, causes, localisation), fendillement, pelage, fait de la poussière, s'effrite, terni, bulleux, calciné, brûlé, pollué (déchets biologiques)

3.4.5- les interventions postérieures: écartement partiel, noveaux enduits, repeints

4- RECHERCHES

4.1- sondage

4.1.1- radiographie (seulement quelques exemples)

4.1.2- éclairage (ultraviolet, infrarouge,...)

4.1.3- sondage mécanique (avec burins, scalpels, forets creux,...)

4.1.4- chimique (solvants,...)

4.2- essais et analyses des matériaux et des techniques (l'assemblage)

4.2.1- essais phisiques

4.2.2- analyses chimiques

5- PROPOSITION D'INTERVENTION

5.1- le cours prévu de l'intervention

5.2- les moyens prévus (outillage, appareils,...)

5.3- les matériaux prévus (évaluation)

5.4- le temps prévu (évaluation)

6- APPROBATION DE LA PROPOSITION DE L'INTERVENTION

6.1- procès-verbal de la commission ou avis du collège professionnel sur la proposition de l'intervention

6.2- avis, observations de l'executant sur les décisions de la commision du collège

7- EXÉCUTION DE L'INTERVENTION

7.1- le cours (les phases) de l'intervention

7.2- les constatations au cours de l'intervention

7.2.1- les nouvelles constatations concernant la technique, l'assemblage

7.2.2- les nouvelles constatations concernant les matériaux documentaires

7.2.3- les changements iconographiques

7.2.4- les nouvelles constatations en liaison avec les interventions récentes

7.2.5- les constatations concernant les endommagements

7.2.6- l'utilisation des moyens imprévus

7.2.7- l'utilisation des matériaux imprévus

7.2.8- le changement du temps prévu

8- DOCUMENTATION

8.1- la documentation textuelle

8.1.1- le remplissage des formulaires du rapport sur l'intervention

8.1.2- les procès-verbaux des travaux des commissions ou colleges professionnels

8.1.3- les avis, expertises, essais, analyses

8.1.4- les copies des documents (transports, assurance,...)

8.1.5- les copies des articles dans les journaux sur l'intervention, l'indication des émissions radio-tv sur l'intervention

8.1.6- les copies des matériaux d'archives sur l'objet traité ou l'indication des sources

8.2- la documentation graphique

8.2.1- croquis, dessins, plans

8.2.2- tableaux, graphiques, diagrammes

8.3- la documentation photographique

8.3.1- la liste avec les numéros d'archives des prises de vues photographiques, cinématographiques, radiographies sur l'intervention

8.3.2- le choix des photo-positives pour le rapport de travail (pour l'identification - avant, pendant et après l'intervention)

8.4- le dépôt des éléments documentaires (pour les objets présentés au musée)

8.4.1- les étiquettes

8.4.2- les cachets

8.4.3- les notes

elles sont déposées, s'il n'est pas possible

de les monter de nouveau sur l'objet après
la fin de l'intervention

9- REMISE DE L'OBJET TERMINE

9.1- la réception

9.1.1- bref rapport de l'exécutant sur l'intervention

9.1.2- décisions de la commission ou du collège qui a procédé à la réception (procès-verbal)

9.2- le transport de l'objet (par morceaux détachés)

9.2.1- la protection

9.2.2- le cours du transport

9.3- le montage éventuel

9.4- la récèption du travail de la part du client

10- MISE AUX ARCHIVES DU RAPPORT DE TRAVAIL

10.1- le complétement de trois exemplaires du rapport de travail (pour l'exécutent, le client et la documentation centrale du service des monuments)

10.2- le règlement de comptes (copie dans le rapport)

10.3- la remise d'un exemplaire du rapport au client et à la documentation centrale (le rapport au client ne contient pas de données strictement professionnelles).

LE CATALOGUE

Dans la contribution se trouvent les projets des fiches pour deux catalogues, à savoir pour le catalogue des matériaux et la catalogue des préparations qu'on utilise dans la restauration.

Dans leur conception, les catalogues ne diffèrent pas des catalogues similaires des autres branches. Ils se composeraient de fiches égales, d'un papier blanc, lisse, un peu plus épais, au format de 105 x 148 mm.

Le catalogue ou le contenu des fiches est une aide incessante pour le restaurateur se décidant pour l'emploi d'un matériau. Les catalogues doivent contenir les données de tous les matériaux et préparations qui sont ou ont été

employes dans la restauration.
Les catalogues se complètent sans cesse en accord avec le développement de la branche et l'utilisation des nouveaux matériaux.

Le catalogue des matériaux

La première page du projet de la fiche se compose de cinq rubriques:

- la première rubrique contient le nom du matériau,
- dans la deuxième rubrique on inscrit tous les autres noms connus du matériau mentionné (synonymes),
- la rubrique suivante contient les données sur le producteur avec son adresse exacte,
- dans la quatrième rubrique on inscrit les données de l'importateur ou du fournisseur,
- dans la cinquième rubrique on inscrit toutes les remarques en liaison avec les rubriques mentionnées (par ex.: le matériau n'est plus fabriqué, les changements chez le producteur, le changement de l'importateur ou du fournisseur,...).

Le dos de la fiche est divisé en trois rubriques:

- dans la première sont données toutes les propriétés importantes du matériau inscrit,
- dans la deuxième rubrique on décrit l'applicabilité du matériau (si possible, inscrire aussi qui a le premier essayé le matériau ou le recommande),
- dans la troisième rubrique (remarques) on inscrit, au besoin, les avertissement, à savoir que le matériau est toxique, inflammable, explosif, qu'on ne l'emploie plus dans la restauration et pourquoi non, en indiquant éventuellement le produit de remplacement. Pour la désignation de la toxicité, de l'inflammabilité et semblable ou utilise les symboles internationaux correspondants.

Le catalogue des préparations

La première page de la fiche se compose des rubriques suivantes:

- dans la première rubrique on inscrit le nom de la préparation. Mais comme la plupart des préparations n'ont pas de nom spécial, il convient d'inscrire le nom qui désigne sa destination (par ex.: "solvant pour les repeints à l'huile", "masse pour l'affermissement de la couche inférieure",...),
- la deuxième rubrique se compose de plusieurs rubriques verticales - colonnes, dont la première est destinée au numéro d'ordre du matériau, la deuxième au nom des matériaux qui composent la préparation, tandis que les autres contiennent la désignation de l'unité de mesure, la quantité, le pourcentage et les remarques (par ex.: froid, chaud, liquide, moulu,...),
- la troisième rubrique est destinée aux observations (par ex.: la description de la succession des matérieux dans la préparation des mélanges, des masses et dans des buts similaires).

Le dos de la fiche est formée comme sur la fiche pour les matériaux.

- La première rubrique contient les propriétés du mélange ou de la masse,
- dans la deuxième on décrit l'applicabilité des mélanges inscrits,..., si possible, indiquer qui a composé ou essayé la préparation,
- dans la troisième rubrique, destinée aux observations, se rangent les avertissements: toxique, inflammable, explosif,... (symboles).

On inscrit aussi, si la préparation n'est plus utilisée, pourquoi elle ne l'est plus et, éventuellement, le produit de remplacement.

LITTÉRATURE (imprimés)

- ISTITUTO CENTRALE DEL RESTAURO, Roma,
- INSTITUT ROYAL DU PATRIMOINE ARTSTIQUE, Bruxelles,
- THE TATE GALLERY, London,
- ZAVOD SR SLOVENIJE ZA SPOMENIŠKO VARSTVO (projet.du dossier de travail - dr. Ivan Komelj), Ljubljana,
- ZAVOD SR SLOVENIJE ZA SPOMENIŠKO VARSTVO (imprimés utilisés)
- REPUBLIČKI ZAVOD ZA ZAŠTITU SPOMENIKA KULTURE,SR SRBIJE, Beograd.

CONSULTATIONS

- collaborateurs du ZAVOD SR SLOVENIJE ZA SPOMENIŠKO VARSTVO, Ljubljana,
- Franc Kokalj, professeur de l'Académie des Beaux - Arts, Ljubljana,
- Michel Savko, INSTITUT ROYAL DU PATRIMOINE ARTISTIQUE, Bruxelles,
- Mirko Šubic, professeur (défunt), Ljubljana,
- Zvonimir Zeković, REPUBLIČKI ZAVOD ZA ZAŠTITU SPOMENIKA KULTURE SR SRBIJE, Beograd.

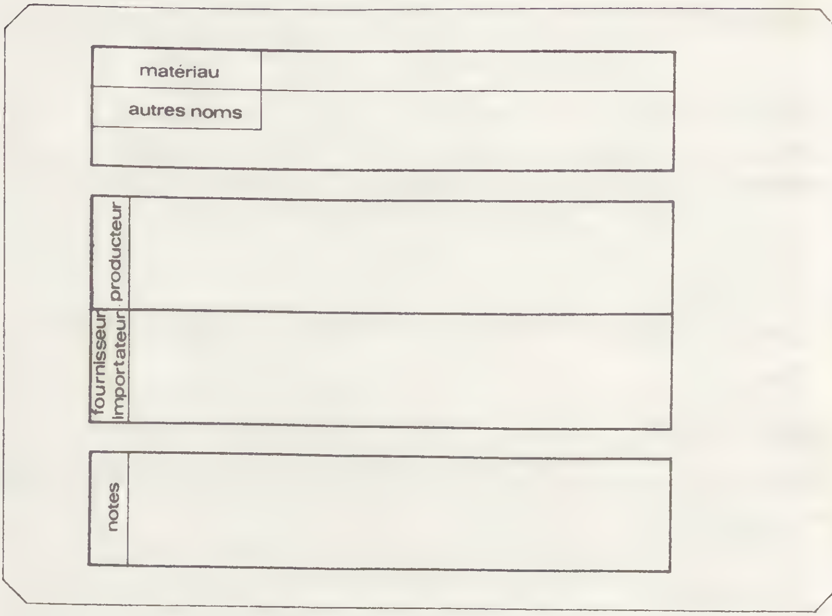

figure 1

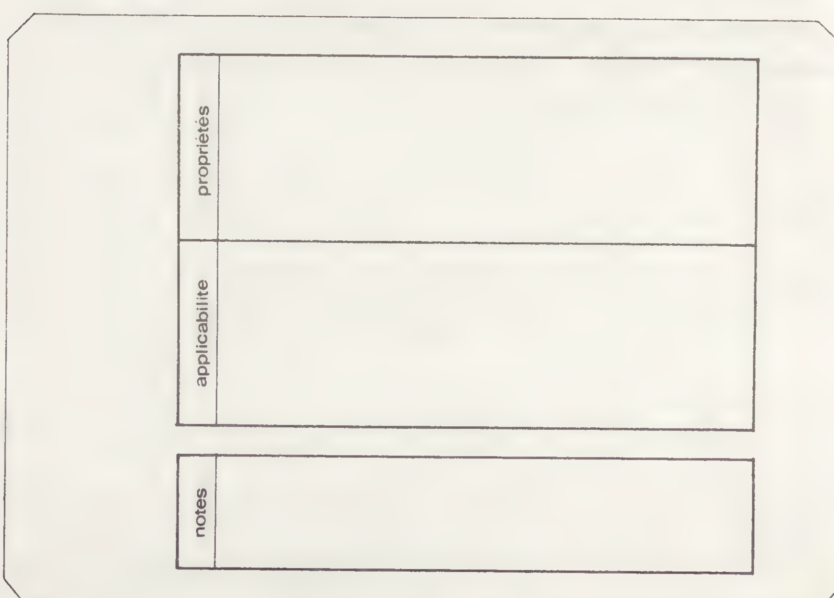

figure 2

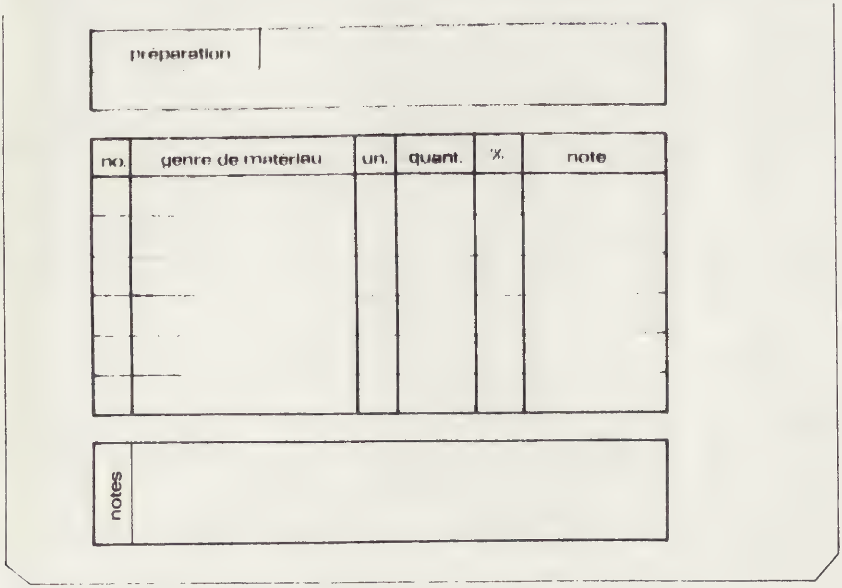

figure 3

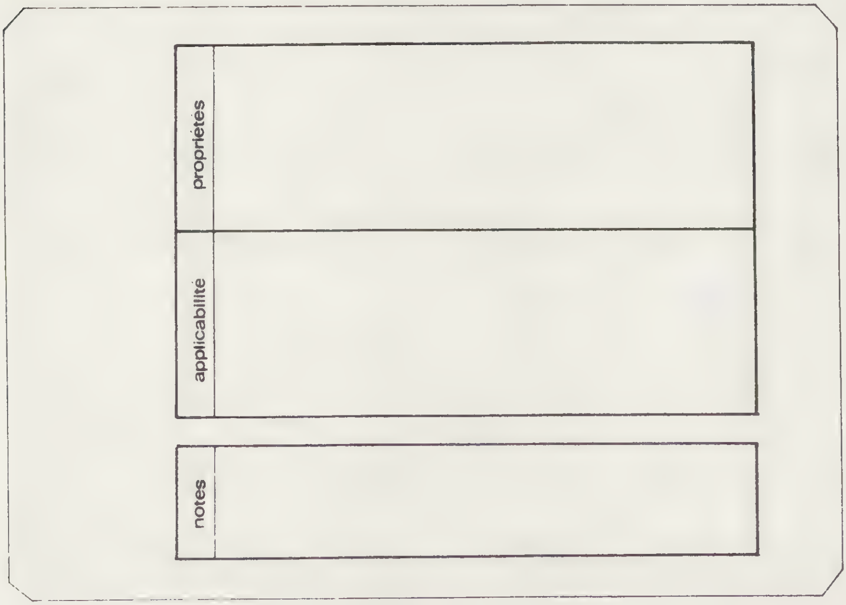

figure 4

POLYCHROMED SCULPTURE

Coordinator	: P. Philippot (Belgium)
Assistant coordinator	: A. Ballestrem (Fed. Rep. of Germ.)
Members	: M. Koller (Austria)
	O. Lelekov (USSR)
	A. Recchiuto Genovese (Spain)
	M. Serck (Belgium)
	J.R.J. van Asperen de Boer (Netherlands)

Programme 1975-1978

1. Organization of a symposium on the examination and restoration of the Crucifix by Bernt Notke in Lübeck (Ballestrem).
2. Examination of polychromy of neo-gothic sculpture (Van Asperen de Boer, Ballestrem, Serck).
3. Examination and conservation of gothic polychrome sculpture in USSR (Lelekov).
4. Examination and conservation of the Sankt Wolfgang Altar by Michael Pacher (Koller).
5. Examination and conservation of polychromed baroque sculpture in Spain (Recchiuto Genovese).
6. Techniques and problems of polychromy of late gothic sculpture in Brabant (Serck).

GROUPE DE TRAVAIL: EXAMEN ET CONSERVATION DES SCULPTURES POLYCHROMES

Coordonnateur: Paul Philippot

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Belgique

Bref rapport sur les principales activités internationales et publications depuis la réunion du Comité de l'ICOM pour la Conservation à Venise en octobre 1975.

Deux importants colloques ont été organisés depuis 1975 à l'occasion de la restauration d'ensembles gothiques tardifs. Il s'agit du Colloque sur l'examen et la restauration du retable de St. Wolfgang de Michael Pacher, organisé par le Bundesdenkmalamt de Vienne (septembre 1975) et du Colloque sur la restauration de la Croix triomphale et du Jubé de Bernt Notke de la Domkirche de Lübeck, organisé par les Services de Conservation de la ville de Lübeck et la Fabrique d'Eglise (22-24 sept. 1976).

Les contributions à cette dernière réunion ont fait l'objet d'une publication en off-set dans laquelle les divers aspects des problèmes posés par la restauration du chef-d'oeuvre de Bernt Notke sont exposés par MM. Eike Oellermann (Heroldsberg), Kurt Schmidt-Thomson (Münster), E.-L. Richter et H. Härlin (Stuttgart), A. Grassmann (Lübeck), Ewald Vetter (Mannheim), Dieter Eckstein (Hamburg) et Arnulf von Ulmann (Lübeck), Gerhard Eimer (Francfort), Sten Karling (Stockholm). Des contributions de MM. Erik Skov et Verner Thomson (Copenhague) sur le retable de Arhus et sa restauration, ainsi que de M. N. Bregmann et Mme O. Lelekowa (Moscou) sur la restauration du retable de Tallinn ont permis d'élargir considérablement les discussions relatives aux problèmes de technologie, de collaboration d'atelier et d'attribution soulevés par ces trois retables, et montrent une fois de plus le lien étroit, et indispensable, entre la restauration, l'examen technologique et l'histoire de l'art. On notera aussi l'apport nouveau, et particulièrement intéressant pour les perspectives méthodologiques qu'il ouvre, des études de dendrochronologie de MM. Eckstein et von Ulmann, qui recoupent, précisent et complètent les données chronologiques fournies par les archives, et révèlent que les chênes dans lesquels ont été sculptées les principales figures ont

été abattus dans la région de Lübeck immédiatement avant les travaux, et donc sans laisser au bois le temps de sécher. Les planches de chêne constituant le Jubé proviennent au contraire des Pays-Bas, et ont dû être expédiées déjà débitées.

Le colloque de Lübeck a fourni à M. Max Hasse (Lübeck) l'occasion d'une mise au point sur les rapports entre sculpteurs, peintres et doreurs dans les corporations de la fin du Moyen Age, parue ensuite sous le titre : Maler, Bildschnitzer und Vergolder in den Zünften des späten Mittelalters, dans le Jahrbuch der Hamburger Kunstsammlungen, Bd. 21, 1976, pp. 31-42.

Le même thème est affronté pour le Baroque dans un article de Manfred Koller (Vienne), Fassung und Fassmaler an Barockaltären, dans Maltechnik-Restauro 3 / 1976, où l'auteur reprend des matériaux présentés par lui précédemment dans Restauratorenblätter, 2 / 1974 consacré au thème Barockaltäre und Barockskulptur, objet du 3e congrès des restaurateurs autrichiens, organisé par le Bundesdenkmalamt les 21 et 22 février 1974. Nous renvoyons les intéressée à cette publication extrêmement riche en informations, à laquelle ont contribué plus de vingt collaborateurs. Outre les problèmes de technologie, d'examen et de restauration, notons les contributions de J. Taubert et de S. Enzinger sur l'intégration de figures gothiques dans des retables baroques.

Signalons encore la parution du Band XXVIII, 1971 du Jahrbuch der Rheinischen Denkmalpflege, qui contient les rapports sur les activités de restauration des ateliers du Landeskonservator Rheinland de 1965 à 1970, où une place importante revient à la sculpture polychrome.

Le problème de la polychromie dans les arts dits primitifs est abordé par Erika Schaffer, Consolidation of Painted Wooden Artifacts dans Stud. in Cons., vol.19, 1974, pp.212-221.

Le rapport complet sur la conservation du retable de St. Wolfgang de Michael Pacher sera publié prochainement par le Bundesdenkmalamt. Egalement très attendue est la parution en un volume, aux éditions Callwey à Munich, de l'ensemble des écrits consacrés aux problèmes de la sculpture polychrome - qu'il s'agisse de questions d'histoire de l'art ou de restauration - par le regretté Johannes Taubert.

Enfin, nous ne pouvons clôturer ce rapide tour d'horizon sans rappeler l'importance, pour tous ceux qui s'intéressent à la polychromie, de l'article de Manfred Koller, Farbigkeit der Architektur, paru dans la dernière livraison du Reallexikon zur deutschen Kunstgeschichte. On attend avec impatience la parution du prochain cahier, qui devra contenir l'article Fassung dont la rédaction a été confiée à Thomas Brachert.

Paul Philippot.

RECONSTRUCTION ET RESTAURATION DES RETABLES A LA GALERIE NATIONALE HONGROISE

Márta Kázik

Résumé. L'exposé rend compte des travaux de conservation poursuivis sur 5 autels à volets parmi autres étant en possession de la Galérie Nationale de Hongrie.

Il n'y a aucun autel à volets qui nous est resté "in situ" dans les églises hongroises. Le Musée Chrétien d'Esztergom possède 3, la Galérie Nationale de Hongrie détient 20 autels à volets plus ou moins complets. Ceux de Budapest sont particuliairement abimés, détruits dû aux aménagements fréquents et aux dévastations de la guerre. Les autels étaient conservés dans plusieurs musées entre les deux guerres.

A la formation de la Collection des Antiquités Hongroises, ils étaient placés dans le Musée des Beaux-Arts. Les restaurations effectuées ici ont surtout mis en premier plan les conservations des vantaux d'autel et celles des statues. Les unités structurales, le tabernacle, la predella, le tympan étaient négligés. Même aux expositions ils arrivaient en pièces. C'est depuis 1974 qu'ils sont à la Galérie Nationale de Hongrie où la possibilité s'est présenté à conserver et à exposer en grande envergure et globalement le matériel.

Au commencement de la conservation notre premier devoir est de définir l'état actuel et original. L'expertise est effectuée par le restaurateur coopérant avec l'historien d'art et les spécialistes dans les sciences naturelles.

La conservation, le néttoyage et les moyens de complètement - et en quelle mesure - sont déterminés par l'état des pieces en question.

Une si grande concentration au musée des restes du Moyen-Age permet de restaurer les triptyques, les panneaux et les statues d'une façon uniforme et déterminée uniquement par le musée. Les travaux sont continués à l'intérieur de l'établissement et ceux-là rendent possible les expertises détaillées, la documentation et le contrôle permanent.

I. La définition du "status quo", de l'état actuel - dans le cas des triptyques - plusieurs fois réparés ou transformés - est un devoir de premier ordre.

Les autels étaient changés bien de fois mais n'étaient pas transformés identiquement au cours du temps. Ils étaient réparés sur place, dans les églises sans les avoir démontés très fréquemment seulement les parties les plus visibles et les plus importantes étaient peintes peut-

être plusieurs fois tandis que l'original est resté intact aux endroits inaccessibles. Après leur arrivé au musée au tournant du siècle et entre les deux guerres mondiales on avait effectué des modifications ça et là, on les avait repeints. Ainsi il faut que nous pensions aux interventions précédentes du musée - c'est-à-dire aux panneaux sciés, aux parquetages, aux complètements. De cette façon, par exemple le dos du tabernacle de l'Annuntiation de Kisszeben /1510-20/ avait été changé au XIXième siècle. Pendant la deuxième guerre mondiale te triptyque avait été gravement endommagé, son tabernacle s'était désassemblé. Dans tous les cas les tympans sont abimés.

Le tabernacle et la predella du triptyque de St. Anne de Kisszeben /1510-20/ avait été repeint une fois, ses reliefs et ses statues plusieurs fois. Les vantaux du triptyque de la Salutation angélique avaient été repeints deux fois, les images des vantaux de l'autel principal provenant du même lieu avaient été complètement repeints fidèlement aux formes. Dans tous les cas les predellas des autels sont restés repeints. En général les réfections des peintures étaient effectuées directement sur la surface original peinte, les nouvelles aurifications sont une fois des bases portées sur l'originale d'autre fois elles sont sur des bases plus neuves à la place des premieres couches grattées jusqu'au bois. La garniture de poudre de bronze et de métal portée sur mixtion est très fréquente.

Les réfections de la peinture sont réalisées à l'aide des colorants à différents agglomérants, à l'aide de détrempte aux granules grossiers ou de couleur à la colle. Dans d'autre cas avec de l'huile au ton plus sombre. Les surfaces azurites se noircissent à cause des réfections effectuées avec des couleurs à l'huile ou des laques oléagineux.

D'un part le bois est vermoulu, frialable, infecté de champignon ou d'insecte en très mauvais état comme dans le cas des autels de Kisszeben; d'autre part il est en tres bonne condition comme la predella de l'autel de Liptószentandrási András.

II. La détermination de l'état original, du "status originalis" n'est possible que dans le cas de la connaissance des modifications.

Le "status originalis" dans certains détails pouvait être précédé d'un état antérieur et intermédiaire: certaines parties de l'autel ont été réalisés différemment que prévu.

La fermeture en forme de trois cintres pleins de la niche de la predella du triptyque de Leibici Anna avait été modifiée en fermeture verticale. Le côté postérieur de la predella était placé devant les niches projetées.

Sur les images on peut remarquer des pentimentos sur plusieurs points.

Nous avons gardé où cela était possible l'aboutement original des triptyques. Dans beaucoup de cas le démontage est inévitable dans l'intérêt de la conservation et de la fixation statique. Nous pouvons faire connaissance des pièces défaites, le travail de l'atelier du Moyen-Age.

Selon nos expériences nos triptyques avaient été façonnés premièrement par des menuisiers. On suppose que c'est le tabernacle du triptyque de St. Anne Kisszeben qui avait été préparé le premier. Le tabernacle terminé était mis sur la predella et on avait gravé son contour dessus. En même temps on avait marqué les troncs des tourillons fixés sur les angles des vantaux mobiles. Après leur construction on avait collé de la toile, à tous les points joints ainsi qu'à tous les défauts de bois, sous la predella et le tabernacle sans ornement et sculpture; puis on avait appliqué une couche avec la craie visqueuse et on les avait polis. Pareillement, on avait appliqué la première couche vantaux avec leurs cadres.

En démontant en pièces le tabernacle du triptyque de Kisszebeni Anna nous avons trouvé une couche épaisse des debris de la première couche. D'après les empreintes c'est sur ce panneau qu'on avait appliqué les premières couches sur les sculptures ajournées du tympan. Quelques poils du pinceau se sont collés dans la couche de fond. Après avoir fini le travail on avait encastré le panneau penché à l'envers dans le tabernacle. Sans aucune doute le travail avait été fait dans un atelier très étroit s'ils étaient obligés d'appliquer des couches de fond aux sculptures du tympan sur le panneau du tabernacle scié a mesure.

Sur les predellas de cette même triptyque, sur une partie recouvert on trouve - pour ainsi dire un inventaire - des décalages précises des ciseaux des graveurs.

Beaucoup de dessins ont survécu le temps sur ou dans les triptyques. Par exemple dans le cas du triptyque de Lipotszentandrási András: sur les vantaux de celui-ci on avait découvert les dessins des rosettes à sanguine /1512/ qui ne sont pas en rapport avec les parties sculptées ou peintes du triptyque.

Sur les vantaux de triptyque de l'Ange de Kisszeben, derriere le relief on peut voir les empreintes des ciseaux et un dessin d'un lyon gravé à grands traits.

Sur le dos d'un ouvrant rigide du triptyque de Leibici Anna deux figures - une silhouette d'homme tenant une lance et une figure levant le bras droit - étaient dessinées avec des instruments de dessin pas encore con-

nus, on peut les voir sur les clichés infrarouges. Dans ce cas-là il est évident que les dessins étaient faits par le peintre du triptyque. Il y a une connexion entre la figure peinte et le dessin.

Le panneau du hausse du tabernacle de l'autel St. Anne de Kisszeben a gardé le dessin de construction des sculptures en forme d'arc en accolade du haut du tabernacle. C'est à l'aide de cela qu'on avait réussi de reconstituer la sculpture rudement endommagée, fragmentée.

Les triptyques sont des souvenirs épigraphiques. Proportionnellement les inscriptions s'adressant au public sont rares. Les mentions concernant le travail d'atelier sont plus nombreuses: des notes se rapportant aux pièces détachées, à l'installation des statues ou aux réparations ultérieures, a part de ceux-là des initiales gravées, des suscriptions et des dates. Ces mentions peuvent etre tres importantes aux datations des retouches et des réparations.

III. Conservations. Nous conservons le bois gravement endommagé en injectant des fortifiants de bois en outre de la protection des surfaces peintes devenues meubles, s'écaillantes. Si cela est possible on stabilise la déformation des panneaux.

Dans la majorité des cas il est nécessaire pour la restauration de l'emboîtage et du collage original de dégaucher les panneaux de bois peints et dorés et de les fixer avec un système de parquettage.

Nous avons impregné le côté du ventail tu triptyque de Kisszebeni Anna de la liquide toluénique de la résine synthétique paraloide B 72 mélangée avec du pentaclorfenol et pendant un mois nous l'avons progressivement découbé dans une gaufreuse. Pendant ce temps nous avons empêché l'évaporation intense du dissolvant. Avant l'imprégnation nous avons fixé les parties s'écaillantes, nous avons enlevé les retouches et les souillures et nous nous sommes préoccupés de la protection de la surface peinte. Après l'évaporation entière du dissolvant nous avons comblé les lacunes du bois des anciennes gerces, nous les avons recollées puis on les a completé d'une systeme de parquets mobiles. Ainsi le coté du vantail du tabernacle découbé a été remis de nouveau et la fixation du relief ainsi que celle des deux piliers était rendue possible.

La conservation et le complètement des lacunes de la predella du triptyque de l'Annuntiation de Kisszeben a été un devoir plus difficile. Nous avons dû enlever les entretoisements anciens parce que cela avait causé la déformation et la détérioration grave du fond. Après la conservation des pièces nous avons comblé les lacunes à grande surface avec des panneaux faits de debris de til-

leul. Le haut du panneau a été joint à la surface de cassure original, on l'avait fixé avec des éclisses et du collage. La partie inférieure fragmentée amincie à 2 mm a été transposé sur le panneau. Ce complètement peu solide et à l'épaisseur dénivélé formé de cette façon peut mieux être actionné.

Le dos du tabernacle du triptyque de St. Anne de Kisszeben avait été construit de 3 planches. Les collages se sont désassemblés et le relief d'ange fixé à l'aide des clous de fer s'est fendu en trois parts et a continué à se fragmenter. Nous avons décourbé le dos et nous l'avons fixé avec un mortaissage caché et nous l'avons parqueté.

Le bois du relief avait été si ravagé que c'est la surface extérieure et la couche de fond épaisse qui l'a gardé de la dislocation. Les pièces s'étaient déformés séparément ainsi sous leur forme nous ne pouvions pas les joindre. L'égalisation et le remplissage avec une liquide conservatrice duraient 3 mois. Après le collage nous avons fixé le dos en collant un tissu de verre avec de la colle synthétique. Nous avons mis trois éléments de support au dos du relief et c'est à l'aide de ceux-là qu'on l'avait fixé sur le panneau du tabernacle. Ainsi le mouvement des deux objets est devenu indépendant.

Nous avons changé les mortaissages ravagés des côtés du tabernacle. Les nouveaux assemblages en forme de queue d'hirondelle avaient été joints à la planche originale apres avoir enlevé les parties abimés puis on avait transplanté les pièces amincies des fragments originaux.

IV. La reconstruction formelle des triptyques. Le rassemblage des composants des triptyques, le complètement de grandes lacunes ainsi que leur reconstructions sont résolubles et nécessaires dans beaucoup de cas. Nous pouvons combler les lacunes si nous avons un photo ou bien un dessin - à notre disposition - de la partie manquante. Le complètement est effectué à l'aide de la matière originale du même matière et de la même technique.

Nous avons préparé le verso manquant tu triptyque de l'Annuntiation car sa reconstruction était nécessaire et unanime.

Au tympan du triptyque András nous avons gardé les complètements précédents, nous avons taillé les deux tourelles /fiale/ manquantes de nouveau d'après les autres - nous avons comblé les petites lacunes mais nous ne nous sommes pas efforcés de reconstruire complètement les formes /le tympan sans aucune doute était plus riche dans sa forme originale/.

Nous avons du compléter les sculptures des tabernacles en vue des raisons statiques.

Nous avons complété les recouvrements du côté fragmentés et incomplets des predellas. Nous pouvons ré-

soudre cela en construisant dedans des éléments de support auxiliaires suivant précisément la forme originale. Dans tous les cas nous avons complété le cadre, le profil des tabernacles et des vantaux.

Nous faisons le completement plastique des statues qu'en cas bien exceptionnels.

Nous avons retaillé de bois la main manquante de l'ange du triptyque de l'Annuntiation, parce que le sceptre original plein d'inscriptions étant dans sa main nous est resté.

Nous avons aussi réparé la moitié de la tête d'une des figures parmi les statues du tympan du triptyque. A cette statue - malgré le fait que nous connaissions un photo du siècle passé de l'Ange et que ces ailes ont été détruits pendant la deuxième guerre mondiale - nous ne les avons pas réparés.

Nous avons fait des éfforts à restaurer complètement c'est-à-dire formellement aussi car partout le complètement des lacunes paraissait non équivoque.

V. Complètements de couleur et de surface. Étant donné que le degré de la détérioration, l'état des tabernacles sont différents nous avons complété chaque triptyque en vertu du jugement distinctif. Les jugements sont rendus toujours difficile quand les différentes parties du triptyque sont abimées de différente mesure. Ainsi nous n'avions pas l'intention de les compléter d'apres une principe unique et unanime.

Le tableau de milieu, les vantaux et la predella du triptyque de Lipotszentandrási Mária qui nous sont restés. Le tympan qui nous est inconnu était perdu. Le bas du tableau de milieu et certaines parties de la surface sont gravement abimés tandis que les autres parties sont relativement bien conservées: presque la moitié de la surface rouge violacé manquait en mosaique. Les couleurs de chair sont élimées, la dernière couche aux têtes des deux anges s'agenouillant est insuffisante. L'argent original du cadre, de l'auréole et du brocart s'est oxidé après que le revêtement lustrine était détruit. La couche de base à craie blanche et de bolus apparaissait de dessous du revêtement métallique râpé.

Vu que principalement c'est les draperies qui étaient incomplets, les completements formels étaient absolument motivés. L'effet de couleur pouvait être retabli simplement avec une retouche sans restitution. Le brocart et l'auréole ainsi que le cadre originellement couverts d'argent et de lustrine dont peu de parties gardaient leur forme originale, ont été retouchés en évoquant l'affet de l'original élimé. Dans tous les cas nous avone restauré à l'aquarelle avec une technique d'hachure appelée "trateggio".

Dans le cas de cette triptyque Mária nous avons employé la méthode de restauration de l'image centrale dans aux vantaux et aux predellas. Nous avons réussi d'assembler les travaux de trois restaurateurs agissant à différent temps et à différent lieu. L'image centrale était finie dans le Musée Chrétien d'Esztergom, les vantaux dans la Galérie Nationale à Budapest et la predella dans un atelier d'un restaurateur du Musée des Beaux-Arts.

Le triptyque St.Anna de Kisszeben n'avait besoin que de très peu d'éléments complémentaires formels. Sa couche de peinture, sa dorrure par contre étaient abimés et étaient repeintes. Notre intention était de compléter l'original le plus parfaitement possible.

Après le complètement formel du triptyque doré nous avons comblé les lacunes en surface et nous l'avons couvert d'une dorrure poliment.

Nous avons restauré - en faisant des petites retouches des défauts de la couche originale de la predella et du tabernacle, relativement en bon état. En enlevant les retouches des reliefs y relatifs nous l'avons retabli d'après la surface originale.

Une restauration précédente avait découvert une retouche provenant du XVIIIième siècle sur les statues du tabernacle et sur les reliefs des vantaux, celles-là avaient été restaurés auparavant. D'après nos analyses cette couche originale en bon état est sous la retouche qui peut être enlevée.

Dans le cas du triptyque de l'Annuntiation de Kisszeben nous hésitions entre l'authenticité historique et la réalisation de l'entité esthétique. Nous avons complété les grands défauts formels de la construction: nous avons restauré avec la retouche hachurée en comblant sa grande lacune le tableau de fond de la predella peinte, en forme d'une niche. Nous avons retabli la surface du nouveau fond du tabernacle selon les côtés latérals: nous avons fait le dessin d'après la technologie originale. Nous avons écarté la couche de base et la peinture provenant de 1887 des statues de la predella. Nous avons gardé les pardessus dorés des statues probablement du XVIII ième siècle car en dessous la surface dorée est si fragmentée que son enlevement est inutile. Nous avons mis dans l'état original la peinture des têtes et des cheveux. Ceux-là étaient découverts de dessous des retouches.

Nous avons découvert les images des vantaux et dans tous les cas nous avons restauré l'original.

Le tabernacle du triptyque de l'autel St. André de Lipotszentandrás est resté dans le meilleur état par rapport aux autres tabernacles- Nous avons completé les sculptures, les lacunes de peinture et de la couche de fond de la surface du tympan: nous avons présenté frag-

mentairement le ragage de la robe brocart finement ciselée d'András, les sculptures du tympan et la surface dorée de la figure du front et les sculptures du tabernacle.

Nous avons formellement restauré les revêtements incomplets du côté de la predella par contre les défauts de la surface peinte, continue du front ont été retouchés à l'aide de la technique à hachure "trateggio" cependant nous avons laissé la partie usée du bas dans son état révélé.

Le triptyque de St. Anne de Leibic est encore sous restauration. La predella et l'un des ouvrants ont été réparés. Nous avons retabli la forme originale de la predella et des sculptures appliquées et nous avons ouvert les surfaces manquantes.

Les défauts de la partie supérieure du vantail du triptyque ne sont pas importants, sa restauration était possible. La retouche de la partie tout en bas dont la restauration serait sans motif à cause du grand défaut. Le complètement du défaut était effectué à l'aide de l'emploi de la technique à hachure. Le complètement des grandes lacunes du cadre était fait selon la technologie à hachures ou de dorrure poliment.

I N D E X

des oeuvres mentionnés en ordre:

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Kisszeben /Sabinov, Cs/: L'autel de St. Anne /MNG 52.757/ fait vers 1510-20 restaurateurs des 1974: Horn Zsuzsa, Kázik Márta, Kákay Szabó Ildikó, Lakatos József, Nagy Sándorné, Szentkirályi Miklós, Velledits Lajos, Seres László

Leibic /Lubica, CS/: L'autel de St. Anne /MNG 53.574/ préparé en 1521; restaurateurs: Szentkirályi Miklós, Velledits Lajos, Radovits Krisztina, Szabó Mariann, Zsolnay Krisztina

Lipótszentandrás /Sväty Ondrej nad Váhom, CS/: L'autel de St. André /MNG 53.569/; 1521; restaurateurs dès 1974: Kovács Zsuzsa, Faragó Ferenc, Kázik Márta

Lipótszentandrás /Sväty Ondrej nad Váhom, CS/:
L'autel de St. Marie /MNG 53.570/ fait vers 1480; restaurateurs dès 1974: Kovács Zsuzsa, Eisenmayer Tiborné, Varga Dezső

La documentation concernant les restaurations sont gardées dans la Collection des Antiquités de la Galérie Nationale de Hongrie

<u>Littérature d'histoire d'art concernant les triptyques</u>:

Radocsay Dénes: Les retables de la Hongrie du Moyen-Age; Budapest 1953

Radocsay Dénes: Les statues de bois de la Hongrie du Moyen-Age Budapest, 1967

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COMPARATIVE STUDIES IN POLYCHROMY: MEDIEVAL ARCHITECTURE AND OTHER SCULPTURES (THE COURTYARD - CHAPEL IN VIENNA)

Manfred Koller and Maria Ranacher

Abstract

In history buildings and their belongings sculptures have at most times been painted after certain concepts of artistic composition or/and material illusion. The different types and principles of these composite polychromies together create the colour-aspect of a built space, but up to now in most cases they are studied or restored separately neglecting their close coherence. In the last restoration of the gothic chapel of the former Courtyard of the Emperor in Vienna the attempt has been realised to set up and compare the stratographic profiles of the built surface with that of its polychromed sculptural decoration at the vaults and pillars. The results obtained were used for the objective criteria and documentation how the interior of the chapel was looking like in its different periods and which phases of polychromie were the historical and artistical right ones for the actual restoration.

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One of the greatest historical errors with serious consequences in the age of Neo-Classicism had been the idea that the ancient sculptures didn't use any polychromie in favour of the noble character of the bare, pure and solid material. From Winckelmann (1755) to Goethe are after the orders for eccliastic worship of the emperor Josef II. in Austria (1786) sculptures had only to like the material they consisted of (1). Consequently prior gilded or coloured statues in the churches had been overpainted to a uniform white or grey as far f.e. up to now can be seen in the most of the churches in Vienna (2). At the same time similar changes happened to many interiors of medieval buildings above all that of Gothic style. These either have been overpainted too by whitewashing in grey, yellowish or white tones or were reduced to their stone-body by mechanical abraising means. This wide spread tradition has been modified by the restorations in the following age of Romanticism with different aims, but without recalling into mind the sources, purposes and compositions of polychromy in a systematic manner as we now try to do. The fundamental divergences of opinions for or against polychromy with ancient statues and architectures can be viewed in the socalled "Polychromiestreit", which lasted till the second half of the 19th century. Important architects like Hittorf, Klenze, Semper, used without doubt in their buildings the "Architetektonische Lithochromie", as Klenze called it, whereas other romantic architect-restorers destroyed authentic polychromies of important monuments like many cathedrals of France, England, Germany or Austria show. A few preserved polychromy-traces, which nowadays we start to estimate and examine more than ever, as they only can recall into our mind the real impression of how medieval space and architectural forms and their unaltered surfaces have been looking like in history (4).

But there are some monuments left, which reveal an early interest into the values of polychromy, like the Sainte Chapelle in Paris with its pillar figures of the 13th century in the cycle of the holy apostels in the cathedral in Cologne dating of 133o. Both of them have been overpainted around 184o very close to the original visible still before as is said by written documents. Whilst the Sainte Chapelle up up to now presents this state of overpainted original polychromy on figures and walls untouched, the romantic state of colour is only left to the figures in the Cologne-Cathedral, which is now in examination by the laboratories of the Landeskonservator at Bonn (5). The walls and pillars have just been totally cleaned to stone decades before.

Similar cases are to be found at several places including very important monuments. Regarding architecture with adhering monumental sculptures we remember to the Reims-Cathedral or Notre Dame in Paris (6) or the Bamberg and Augsburg-Cathedrals in Germany (7). At the latter ones recently the remainder of the polychromy of the sculptures are in examination. But it has never been possible to draw an integrate search of both architecture and sculptures to demonstrate their relating colour aspects in origin and later after all the alterations up to our time.

<u>The examination of the Courtyard-Chapel in Vienna</u>

Due to the puristic restorations of the 19th century we only know little about details of medieval polychromies in the about 20 gothic churches preserved in Vienna. Except two buildings, the cathedral of St. Stephan and the chapel of the former Emperors Courtyard, the building of the latter follows the famous Saint Chapelle in Paris. Both naves of the 15th century contain cycles of statues in their pillars, of late gothic style but not contemporean to the building. The Courtyard-Chapel was built in 1449. At this time only the 4 relieve-busts which form the keystones must have been ready on their places including the

first polychromy. The 12 wooden statues of the Annoncioation and Saints date from 1480/85 and are close to the famous workshop of Niclas Gerhaert van Leyden.Further relation to the figures with the architecture compare Fig. 4.
Vaults: a) Salvator, b) Madonna with child, c) Saint John Evangelist, d) Saint Michel
Pillars: A) Mary, B) Angel Gabriel, C) Saint Catherine, D) Saint Margaret (Fig. 5 and 6), E) Saint Ägidius, F) Saint Christoph, G) Saint Cyrial, H) St. Dionys, J) Saint Koloman, K) Saint Sebastian, L) Saint Bishop (Blasius?7, M) Saint King (Leopold?), N) Saint Man (Vitus?)
On behalf of the 1977 - restoration of the laboratories of the Bundesdenkmalamt in Vienna we had to set up the stratographic profile of all polychromies in place: walls, pillars, vaults and sculptures. The keystone-busts had just been brought to their original stage at 1955 (first layer of colours and guilding) with some reports and left about (8). The pillar sculptures on the other hand had been cleaned in 1926 very primitivly for an expostion, destroying more than half of the delicate gothic polychromies and leaving no written account. But there have been left numerous spots of overpaints by which we could set up the comparison of layers. The full documentation and interpretation of the results obtained has recently been published in connection with the presentation of the wooden statues in the Kunsthistorische Museum Wien, in summer 1978 before the will go back to their elevated place on the chapel walls (9).

In this paper we want to present a brief summary of the results useful to indicate the methodical way for complex restoration decisios like this. The absolute chronology is only partial possible by help of written notes about prior restorations of the interior. It is remarkable that the sculptures had been touched less than the building. There was no direct stratographic coincidence possible so we had to combine the date of the overpainting of the

figures only by other reasons without definite security. In the field of the architecture only the vaults made a full scale of the polychromy-layers possible, which nevertheless could serve as a key to guide the interpretation of all other polychromies in question (fig. 1-3).

For the restoration it was not posible to come to an equal historical level of figures and architecture and this for different reasons. All sculptures had to be restored to their original late gothic polychromy (phase 1). On the other hand the architecture has been dominantly altered in parts in 18o2, which could not be taken to reverse. Therefore the polychromy of 18o2 (phase 1o) has been chosen for renovation and other layers only kept in parts of documentation. The cleaning of the thick overpainted ribs and vaults was executed with caution and the most valuable prior layers (phase 1 and 2) are still preserved und the following whitings phase 3 to 5 left and at least that new one of 1977.

Comparative stratigraphy of polychromy-profiles:

Date	Layer	Ribs	Walls	Keystone Madonna with Child	Statue of Saint Margaret
1449 (Statue St. Margarete 148o/85)	1	grey; vaults: red/ green/ blue	white; vaults: green/ red ornaments	cloak outside,darkblue,reverse lightblue; cloth darkblue	cloak outside darkred, reverse azurite; cloth green on silvering
16th c.	2	yellow ochre	white	--	--
?	3	beige	light ochre	--	--
1639	4	pale yellow	light ochre	garment layers missing,but carnat positive	cloak outside red, reverse greyblue; cloth green

1683	5	greyish beige	yellowish beige	--	--
1713	6	yellowish beige	yellowish beige	--	--
1748	7	yellow ochre	grey	cloak light-blue on silvering;cloth red on gilding	cloak outside pink, reverse greyblue; cloth greenbrown
?	8	yellow ochre	beige	--	--
?	9	yellow ochre	grey	--	--
18o2	1o	pale pink	light grey	white	white
1822	11	umbra	yellow ochre	white	white
1843	12	umbra	brown	--	--
1861	13	grey	grey	--	--
?	14	pink	pink	--	--
?	15	green	green	--	--
1926(?)	16	grey	blue vaults	--	1. restoration
1939(?)	17	grey	grey	--	
1955	18	lightgrey	lightgrey	1. restoration	
1977	19	see 1o	see 1o	only soft cleaning	2. restoration

<u>References</u>:

(1) Handbuch aller unter der Regierung Kaiser JosephII. für die k.k. Erbländer ergangenen Verordnungen und Gesetze, 6. Band, Wien 1786 (für das Jahr 1784), p.579, 581, 584. - Friedrich Christian Schmidt, Der bürgerliche Baumeister etc., Gotha 179o (published partly by U. Boeck in: Deutsche Kunst und Denkmalpflege, 29, 1971, S. 35, ff.) recommends for painting the statues:"pure white or light white-grey is the best colour".

(2) M. Koller, Barockaltäre in Österreich. Fassung, Technik und Restaurierung, in: Restauratorenblätter der Denkmalpflege in Österreich, 2, Wien 1974 (ed.1976), p.3o

(3) P. Reutersward, Studien zur Polychromie der Plastik. Griechenland und Rom, Stockholm 196o, p. 9 - 27; F. Kobler - M. Koller, Farbigkeit der Architektur, in: Reallexikon zur deutschen Kunstgeschichte, vol. 7, Sp. 276 f. (1975)

(4) The importance of the polychromy conserved to define the original form and their surface must be specially emphasized. This is clearly to be seen at the Lausanne-Cathedral, where the nave and crossing has been brought to pure stone, but the right chapel aside the presbytery still conserves its late romanic polychromy

(5) Kolloquium zur Restaurierung der Kölner Domchorausstattung Cologne, november 1977

(6) W. Sauerländer - M. Hirmer, Gotische Skulptur in Frankreich 114o - 127o, München 197o, colour plate IV; recent examinations of the Laboratoire des monuments historiques, Champs sur Marne.

(7) Recent examinations of the Augsburg-Cathdral-portals by the Doerner-Institut in Munich

(8) J. Zykan, Die Schlußsteine der Burgkapelle in Wien, in: Österr. Zeitschrift für Kunst und Denkmalpflege, X, 1956, p. 49 ff.

(9) M. Koller - M. Ranacher, Die Hofburgkapelle in Wien: Untersu chung, Dokumentation und Restaurierung des Innenraumes und seiner Skulpturenausstattung, i n: Österr. Zeitschrift für Kunst und Denkmalpflege, XXXII,1978

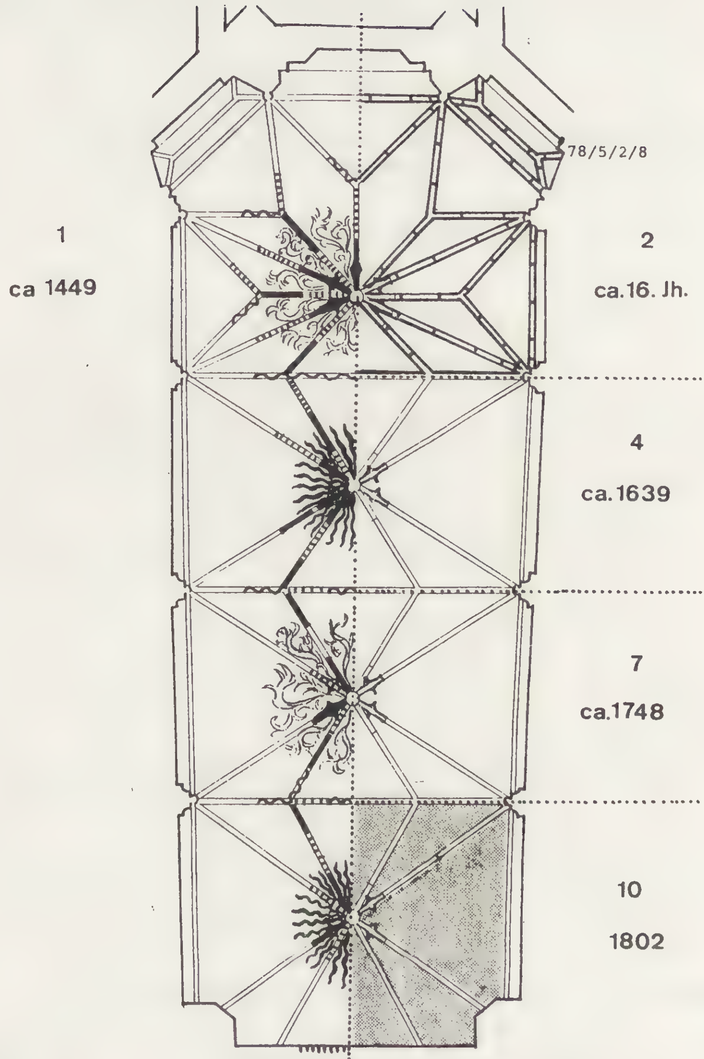

Fig. 1:

Vaults with demonstration of different states of polychromy: 1 rich painting in red, green and blue to grey ribs and white walls - 2 yellow ochre ribs white walls - 4 and 7 yellowish and greyish - 8 pink and grey

Fig. 2: Systems of black joint- and outlines in the first and second phase of the polychromed ribs of the vaults (1449 and 16. cent.)

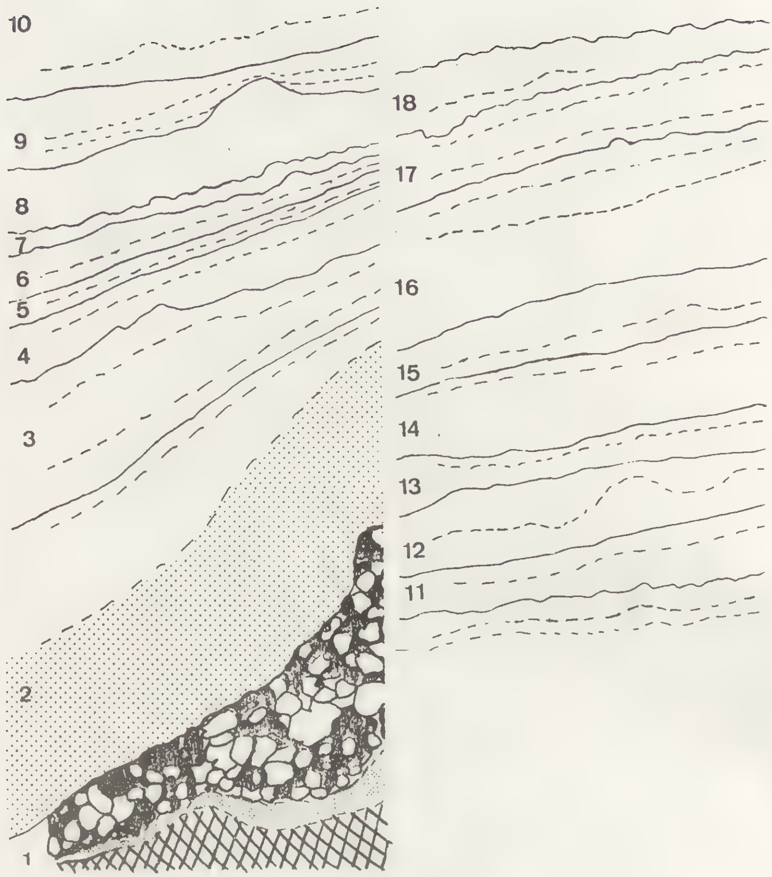

Fig. 3:

Cross-section of an originally green polychromed part auf the vaults-ribs including all 17 layers of overpainting from 16th to 20th centuries (cross-hatched parts = sandstone, pointed areas = plaster, black and white grains = crystalline copper green and white)

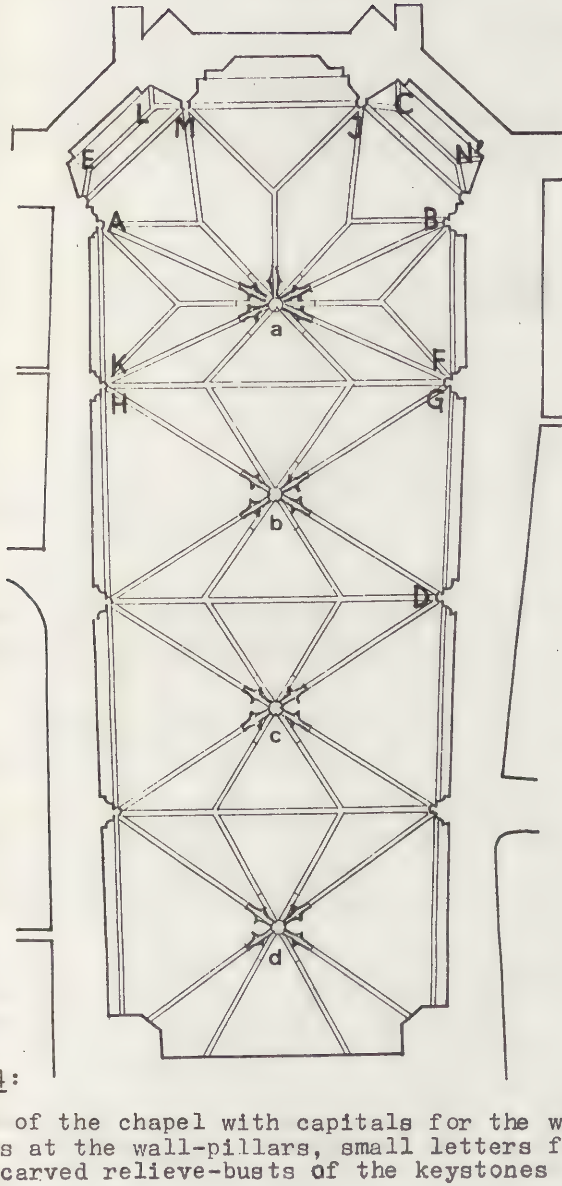

Fig. 4:

Scheme of the chapel with capitals for the woöden statues at the wall-pillars, small letters for the stone-carved relieve-busts of the keystones

1

2

3

Fig. 5

Saint Margret (cf.Fig.4/D): original polychromy (1, ca. 1480/85) with its two different coloured overpaintings (2, ca.1639; 3, ca. 1748). The third layer (4, 1802) showed undivided white oilcolour

lustre on silvering

burnished gilding

bright colours

mat blue (azurite)

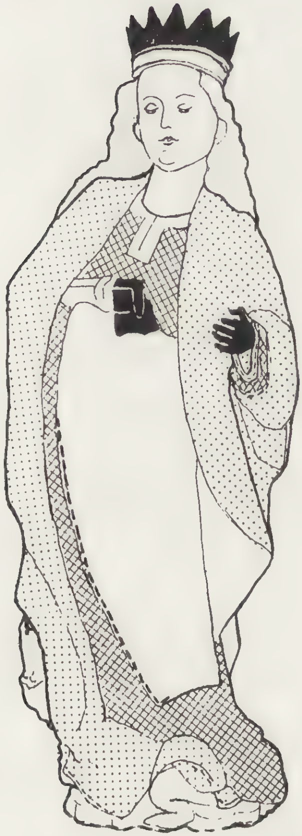

Fig. 6:

Saint Margret (cf. Fig.4/D)

State of conservation aufter restoration 1977

(black = old supplements left

white = original polychromy in good condition

crossed hatchings = original lustre in bad condition with overpaintings left

great dotting = original colours reduced

small dotting = original colours in bad condition with overpaintings left

interrupted lines = damages to the carved form)

THE EXAMINATION OF FIVE POLYCHROME STONE SCULPTURES OF THE LATE 15TH CENTURY IN UTRECHT

C.M. Groen

ABSTRACT

The polychromy of five late 15th century North-Netherlandish sandstone sculptures was investigated.
The sculptures had retained their original polychromy and were overpainted only once. The surface of the stone appeared to have been treated with glue. Depending on the final painting, different underpaintings were applied: a grey glue-bound paint under azurite, a red oil paint in certain other areas, but no coloured underpainting under the white parts. Gildings were done upon an ochreous layer.
On the layer of original flesh paint a glaze containing some brown and black particles was present. A similar layer was found in the white parts; there the yellow dyestuff Persian berries was identified.
The following pigments have been found: lead white, chalk, gypsum, malachite, azurite, lead-tin yellow, red lead, red ochre, brown ochre, vermilion, purpurin lake and bone black in the original paintlayers, and smalt, lead white, blue bice, a basic copper-lead chloride and Pattison white in the overpainting.

INTRODUCTION

Most polychrome sculptures, placed in a church, have been subject to treatments like cleaning and overpainting. The original polychromy has often been faded away for long times, leaving the sculptures as they are. It strikes, when reading publications in the field of research of polychrome sculptures, that much more research is done in polychromy on wood than on stone.[1)]
Some studies of polychromy on stone also dealt with stone sculptures that had their place outside a building, which is more often the case in France. On these sculptures, exposed to influences different from those inside churches, only traces of polychromy could be found. That is the reason why our investigation was short of material with which outcomes of research might have been compared, taking into account that it is as yet the question whether it is possible to compare on one hand outcomes of research of polychromy on wood and of sculptures outside buildings with on the other those of stone sculptures inside buildings; in other words, whether technical differences can occur. [2)]
It is our intention to contribute, in co-operation with the ICOM working-group by the outcomes of our investigation of the polychromy on five sandstone sculptures, to the knowledge in this field.
The five sculptures, representing St. Mary Magdalene, St. Agnes, St.George, St. Paul and St. Martin, offered a unique opportunity for the investigation of polychromy on stone of the end of the 15th century in the Northern Netherlands, since these sculptures are almost the only stone

sculptures in the Netherlands and because their original polychromy, with only one overpainting, is still present, as was proved in an early stage of examinations.
It was concluded therefore, that they had been placed inside a building.
The examination of the various layers of paint was meant, beside to obtain reference data concerning polychromy on stone of that period, to find out whether sufficient of the original polychromy was still present and whether it was worth while to remove the overpainting and thus uncover the original. The outcomes of the research were continually compared with the findings of mr. W.J. Mares, who is the restorer of these sculptures. We also hoped to find answers to other questions. One of these questions was if a conclusion could be drawn from the materials used and technical methods whether the five sculptures belonged together or not. Another question concerned the possibility of the sculptures being sooted by candles, which might give information about their original position in the church.

INVESTIGATION

The sandstone sculptures, which have an average height of 65 cm, were unpainted at the backside. Paintings as well as gildings were found at the frontside. The sculptures, and more detailed the layers of paint and gildings, were looked at and studied by means of a stereomicroscope, searching thereby for traces of polychromy in worn places. Thus working, we found smalt in the top paintlayer in the blue parts. From this we concluded overpainting in a period not earlier than the middle of the 16th century, when, as is assumed, smalt as a pigment came into use. Under this overpainting the underlying paintlayer was in some places visible. We then took paintsamples of the different coloured parts of each of the five sculptures. Of most samples a part was used for making a cross-section, other parts were used for analyses. [3)]

PREPARATION OF STONE AND GROUNDLAYERS

It seemed, on first sight, that a general preparation of the stonesurface had not taken place. [4)] Such a layer, usually existing of a mixture of chalk and glue, is almost always found with wooden sculptures. But staining-tests, done with several paint cross-sections, proved that the stone-surface did undergo a pre-treatment before it was painted. These tests showed the presence of protein close to the stone-surface, which makes treatment at that time with animal glue very likely. [5)]
The function of such a layer of glue, which was, according to old recipes, also used on other carriers like wood and linen, was to diminish the absorption of the paint by the stone. After the treatment with glue, paintlayers of which the colour depended on the final painting, were spread over the still rough stone-surface. Thus to be gilded parts, flesh-coloured parts, attributes and grass were underpainted with red lead, some lead white and ochre in an oil medium, the blue parts with a mixture of bone black and chalk in a glue medium. Under the white painted parts of the clothes, however, we could find neither traces of a coloured nor of a white underpainting.

The sandstone itself is white to yellowish white of colour. Influencing the final colour was apparently one of the most important functions of this layer. In the painting of wooden sculptures too, the use of a dark underpainting under blue (azurite) was a common technique. We did not only investigate colour and composition of the groundlayers. We also thought it advisable to establish -if possible- the order in which the layers had been applied on the stone surface, because this might give possible clues to the answers to some of our questions.

We found in places where the red and grey preparation-layers overlap each other that the red lead layer was spread first, and accordingly the grey one. This can been seen in samples taken from the sculptures of St. Martin, St. Paul and St. George.

GILDING

The gildings appeared for the greater part to be in the original state. They occur on hair and crowns of St. Mary Magdalene and St. Agnes, on pipings of the clothes of St. Mary Magdalene, St. Agnes, St. George and St. Paul, on shield and armour of St. George, on saddle and mounting of the harness of St. Martin's horse.
Prior to the application of the gold-leaf a second layer of paint was spread over the layer of red lead. This one was ochreous and appeared to contain lead white, mixed with some ochre and some red-lead in varying quantities. Microscopically the underlayer for gold on each of the five sculptures looked rather alike. It is remarkable that with the samples of St. Paul a layer of red ochre is present between the layer of red lead and the goldground. This layer was also found on St. Paul between the layer of red lead ground and other layers of colourpaint. Its function is as yet not clear and only shows a difference in build-up compared with the other sculptures. This layer might indicate that the sculpture of St. Paul did originally not form part of this ensemble.

By means of staining-tests and heating of small slices sample material the presence in the goldground was proved of both proteins and an oily substance. Heating to 210° C caused the layer of paint to become dark brown and swollen, whereas a solution of amidoblack showed spread grains of blue. Because of this it can be assumed that an emulsion was used as an adhesive for the gold.

It can be seen from cross-sections of samples taken from St. Paul and St. Martin, in places where the blue part overlaps the gilding, that the underlayer for gold and the gold-leaf had been applied after the grey preparation layer and before the painting with azurite. The crowns of St. Mary Magdalene and St. Agnes, the shield of St. George and the clothes of St. Martin were decorated on their gildings with a glazing red paint. The presence of purpurin lake in the samples of St. Mary Magdalene, St. Agnes and St. George was proved by means of thin layer chromatography.[6)] In the sample of St. Martin it appeared impossible so far to identify the red dyestuff.

The cross on the shield of St. George was painted with a mixture of lead white and a red dyestuff, purpurin lake. The edges of the cross were glazed on the gilding with purpurin lake.
In the case of the apparently black flower motives on the shield of St. George it was only clear that green glazes were present after the cross-sections had been made. This green glaze had become much browned. Green particles could be distinguished microscopically and the test on copper proved to be positive.

FLESH PAINT

The flesh-paint on each of the five sculptures is still practically intact, though covered with an over-painting. The original flesh-paint was lead white, tinted with a little vermilion in an oil-medium (microscopy and staining-tests), with a little organic red pigment added on the lips and cheeks.
Some organic red and also some blue pigment was added on the upper arm and the leg of the beggar with St. Martin and some black on the forehead of St. Paul. Except the painting of the forehead of St. Paul, the painting of the original flesh-coloured parts consists of one layer of paint only.
There is, between the original paintlayer and the overpainting an irregular "layer" of some black and brown material, on examination of the first samples taken for dirt. A suchlike material was found between layers of white paint, which are discussed later. But, in the course of the investigations, we became increasingly aware of the fact, that this material did not consist of dirt only. This "layer" had a regular appearance in small paintsamples, taken from the cheek, lips and nostril of St. Mary Magdalene and from the lips and cheek of St. Agnes, where the black and brown appeared to be enveloped in a transparent material, somewhat similar to varnish. This material did not, howver, fluoresce, which ruled out varnish. This "layer" is in most places $\pm$ 5 μ thick, with peaks of up to 15 μ. The paintsamples were extremely minuscule and the places where they had been taken from too delicate to take further samples for the analysis of the material. Important was to find out whether we had to do here with an original glaze and not just dirt. An indication for its being original was obtained from samples of the overpainted flesh-coloured parts of the beggar of St. Martin. Here too, the flesh-paint had been painted over once (except on the foot), while the half-transparent"layer" was found again between the original paint-layer and the overpainting. There was a layer of varnish (fluorescence) on this "layer". It was assumed for the following reasons that we were dealing with an original glaze, and that the varnish was a later addition:

- the paint-cross-section showed that varnish, through cracks via the half-transparent "layer", penetrated into the original paintlayer (fluorescence);
- the interface between the half-transparent layer and the varnishlayer was clearly visible; in the case of just dirt, part of it would have been taken up by the varnish;
- apart from black particles (dirt?) brown pigment particles can be distinguished clearly by microscopical observation; the glaze on the beg-

gar with St. Martin is less transparent because of the presence of a white pigment (not yet analyzed);

- in the half-transparentlayer upon the original paintlayers in the white parts the yellow dyestuff Persian Berries was identified by means of thin layer chromatography. 7)

It strikes that in samples taken from the beggar this dark half-glaze is more pronounced than on the flesh-coloured parts of the other sculptures. A possible reason for this might be that the beggar in origin has been made dirty deliberately. One wonders why the painter did not darken the paintlayer on the fleshcoloured parts at once by adding a black pigment. The reason, in our opinion, is, that in this case we have to do with a beautification of the surface, like in the case with the white parts, since glaze is also present on other places on the flesh-coloured parts.
An indication for an original dark-coloured glaze on the flesh-paint on the beggar was found in the colour of the overpainting. Whereas the overpainting of the fleshpaint on the other sculptures does not differ much from the original paintlayer, the one on the beggar is coloured much darker and even to such an extent, that we at first sight thought that it was clothing instead of a flesh-coloured part (original lead white, some vermilion, some blue (azurite?) and organic red pigment; overpainting: ochre, lead white, some red ochre). This might indicate that the fleshpaint on the beggar has been dark from the beginning.

WHITE PARTS

The mantles and upper garments of St. Mary Magdalene and St. Agnes, the mantle of St. George, the upper garment of St. Paul and the coat of the beggar were all covered with a white overpainting. Cross-sections of all samples of these parts showed, under the overpainting, the presence of a lead white containing oil-paint (staining-technique). Apart from some impurities, no traces of a differently coloured paint-layer or gilding were found. At the outset of our research we assumed that the polychromy on the sculptures originally had a much more colourful appearance (see the report by drs. H.J. de Smedt, preceding this one). The original paintlayer (15 - 130 μ thick) was, after the glueing of the stone, applied without a further underpainting layer. The originality of the white layer was proved by an overlapping with an azurite-containing layer in a sample of St. Mary Magdalene and in one of St. Agnes. Between the original white paintlayer and the over-painting the dark material (as described with the fleshpaints) was found, though a bit more irregular than with the fleshpaints and not in every place. When, during the restoration, the white overpainting on St. Mary Magdalene and St. Agnes had been removed locally, some of this material was scratched off for analysis by means of thin layer chromatography, with which absence of resin and of organic red dyestuffs was determined and presence of an organic yellow dyestuff, which was identified as Persian Berries.

We inferred that the lead white containing paintlayer with the originally yellowish glaze, which together must have been cream-coloured white, must have been intended as an ennoblement of the in itself "ignoble" sandstone.

BLUE PARTS

Glue-bound azurite is found in the lining of the mantle, the lining of the sleeve and the gallipot of St. Mary Magdalene, the lining of the mantle, the sleeve of the undergarment and the girdle-book of St. Agnes. Azurite was also found in the lining of the mantle and the laurel-wreath of St. George, the lining of the mantle and neckerchief of St. Martin and reins and harness-leather of the horse, the undergarment and lining of the uppergarment of St. Paul.
In most cases the blue parts showed a later overpainting with a mixture of smalt and lead white. There is dirt in some places between the original layer and this overpainting. A thick layer of coarse azurite is present in the samples, but these samples were, after all, taken intentionally from places where, by means of the stereo-microscope, rests of the original blue paint could be seen, such as in depths of plies in garments. In other places the crispy paintlayer is worn, leaving only the overpainting, or, as is the case in the lining of the uppergarment of St. Paul, except in the place where the sample was taken, no paintrests at all.

The harness-leather and the reins of the horse were not painted blue again, but were overpainted with a red oilpaint (vermilion), changing the colourscheme of this sculpture drastically: the horse, originally light bluish-grey (lead white, charcoal, some azurite) became after overpainting brown, and its blue harness-leather became red.

MISCELLANEOUS

Several green tints could be seen in the grass in the foreground of the sculptures. The question was, which of these green colours belonged to the original painting of the grass and which to overpaintings. Paintsamples were taken of the various coloured green parts in the grass and examined. The examinations showed, that the green was applied usually in two, sometimes in one layer, with a mixture of transparent copper green, lead-tin yellow and lead white. In cases where two paintlayers were found sometimes the uppermost, sometimes the underlaying layer had turned brownish, probably depending on the proportions of pigment and medium. We called the green transparent copper green (copper-resinate?) because the pigment gave no distinct X-ray powder-pattern, the absence of a crystalline form microscopically, the behaviour after treatment with acids and the positive test for copper.
The grass in the foreground of the sculpture of St. Martin was first painted with a mixture of malachite, chalk and gypsum; this layer was then covered with a layer of red lead and repainted with the green paint, identical to the one used on the other sculptures. 8)

On the other sculptures red lead was found directly on the stone. From the facts that the green layers on the sculptures contained the same pigments and that neither between red lead and paint-layers nor between the green paintlayers dirt was found, it was concluded that in the places where these samples had been taken, the paint-layers were original. Underpainting in a reddish colour under green has been observed more often in research on painting-technique.

Contrary to the build-up of the grass on the other sculptures, on the sculpture of St. Paul a layer of red ochre was locally found between the red lead and the green paint-layers.
St. Paul is also the only figure on which the whole of the foreground was overpainted. This overpainting stretches itself over the damage in the right hand bottom corner where as a matter of course no original paint-layers were found. The overpainting layer is a bluish-green with locally white on top. Dirt was found between the paintlayers.
In order to find out more about the history of the sculptures, also the overpaintings were analyzed. In the cross-sections of the bluish-green overpainting tiny, round, very pale green crystals and particles of smalt could be recognized. X-ray diffraction showed a mixture of a basic copper-lead-chloride (Cumengite, $Pb_4Cu_4Cl_8(OH)_8 \cdot H_2O$), a basic copper-chloride ($CuCl_2 \cdot 3\{Cu(OH)_2\}$), azurite ($Cu_3(OH)_2(CO_3)_2^2$), smalt, gypsum and leadoxide ($PbO \cdot 0,33H_2O$).
In the white overpainting Lanrionite (Pattison white, $Pb(OH)Cl$) was found. Since Pattison white was first manufactured by Pattison in 1841 it could be concluded that the white belonged to retouchings from the last century. However, this date did not provide us a safe terminus post quem for the whole of the overpainting, since in addition to the overpainting local retouches were found which were possibly much later. The parts containing Pattison white belonged to these retouchings.

The mixture shown in the green overpainting did not bring us much further concerning the determination of the age of the overpainting. The presence of smalt in it points in the direction of an overpainting after ± 1550; about the use of the mineral Cumengite as a pigment no information could be obtained. Also at the Centraal Laboratorium Cumengite was never found in paintlayers. Still it is interesting in so far it can be added to the list of new kinds of old green copper pigments. [9)]
A damaged corner on the sculpture of St. Mary Magdalene had not been painted in with this mixture. There a paintlayer was applied containing a blue pigment, identified as Blue bice as a main constituent. Blue bice was recognized because of the round form of the crystals which were smaller than those of azurite and having the same chemical composition as azurite. Artificial blue copper pigment seems to be manufactured through the centuries, which makes it unlikely that it could be used to determine the age of the overpainted damaged corner.

CONCLUSIONS

The examination of the polychromy of five sandstone sculptures gave insight into the question as to how far the polychromy is original and which parts are overpainted.
This information was used for the restoration, in which some parts of the original paint were uncovered, while in other parts the overpainting was preserved. (See the report of Mr. W. J. Mares following this one). Moreover, through the examination of the five sculptures, we have come to know a bit more about polychromy on stone.
Since our findings in this work differ on certain points from the results of investigations of polychromy on stone elsewhere and from findings on polychromed wooden sculptures, we are eagerly awaiting more publications on this matter.
A few specific questions could be answered by this investigation. The question if there were technical differences between the sculptures (which would suggest, that they did not belong to one group originally) can be answered by stating that the materials used and the building up of the paintlayers on the sculptures are similar. Only on St. Paul did we find an extra layer of red ochre between the red lead ground and the gildings and paintlayers. Of course, this alone is not sufficient to infer that the figure of St. Paul was not standing with the other sculptures originally, but together with stylistic data it can give an indication.
We did not make much progress concerning the question whether or not the sculptures were subject to sooting by candles in a church. Soot may perhaps be responsible for the black particles in the glazing layer and in the dust between original paintlayers and overpaintings. It is, however, difficult (and impossible in this case with tiny samples) to discern between soot and other kinds of dirt or dust. Therefore, we have decided to make a special study of the surface of the sculptures as to the sooting question, when the original polychromy is visible.

NOTES

1. Ballestrem, A., 'Sculpture Polychrome - Bibliographie', Studies in Conservation, 15 (1970), 253 - 271.
2. Reference data in the Central Research Laboratory were the results of the investigation of the sandstone votive retable of the Pot family in the Dom church of Utrecht. This is in fact of a later date (shortly after 1500), but also in this case the original polychromy and gilding have been preserved for a great part.
3. Methods of analysis, as used in the Central Research Laboratory, are described in:

A. Broekman-Bokstijn, M., Van Asperen de Boer, J. R. J., Van 't Hul - Ehrnreich, E. H., Verduyn - Groen, C. M., 'The scientific examination of the polychromed sculpture in the Herlin altarpiece', Studies in Conservation, 15 (1970), 370 - 400.

B. Mosk, J. A., 'Analytical methods applied in the investigation of the Bardwell samples', Studies in Conservation, 20 (1975) 103 - 108.

4. With regard to the question if the five sculptures are of the same origin the type of sandstone was studied. Dr. J. Hofker (the Hague), authority on the Foraminiferae of the Cretaceous period,was consulted. He characterized the stones as coming from glauconitic limestone sedimentary depositions. Microscopically in samples and thin sections of all the five sculptures besides quartz and chalk (partly in the form of skeletons) green particles could be seen. These are of the mineral glauconite. The skeletons are of Gavelinella (or Gavelinopsis) and of Rotalia. Both forms lived in the Upper Cretaceous period and occur generally in sand-limestone depositions in the Dutch South Limburg and the near parts of Germany, Belgium and North France.
5. Staining technique, as applied in the Central Research Laboratory:

   The sample, embedded in polyester resin, is sliced by means of the microtome. Slices are subjected to the following treatments:
   - 1% solution of Fuchsin in water, washing for 10 minutes in 3% acetic acid. A red stain indicates proteins.
   - When a red paintlayer has to be tested a staining with Fast green (0,1% in water) yields a better visible result. A green stain, which is visible for maximally half an hour, is due to proteins.
   - Since certain proteins are only revealed with a distinctly acid reagent, three different solutions of amido black are used, as described by Martin (reference below). Proteins are stained blue.
   - Heating: melting at 60°C: wax; browning at 120°C: natural resin; brown glossy above 180°C: drying oil; buff to brown glossy above 200°C: egg yolk.

   The recipes are derived from:
   Gay, M.-C., 'Essais d'identification et de localisation des liants picturaux par des colorations spécifiques sur coupes minces', Annales du Laboratoire des Musées de France, 1970, 8 - 24.

   Martin, E., 'Some improvements in techniques of analysis of paint media', Studies in Conservation, 22 (1977), 63 - 67.
6. For purpurin lake, see note 3A, p. 382, footnote 13.
   The TLC analyses by miss W. G. Th. Roelofs are greatfully acknowledged.
7. Persian Berries is the yellow dyestuff, that was extracted from the unripe berries of Rhamnus species (buckthorn). Recipes for this occur already in the 15th century.
8. The pigments in the green layers have been analysed by X-ray diffraction. Mr. P. B. Hallebeek is to be thanked for the analyses.
9. Van 't Hul - Ehrnreich, E. H., Hallebeek, P. B., 'A new kind of old green copper pigments found', Paper at the Congress in Madrid, 1972, of the ICOM Committee for Conservation.

LATE 19TH CENTURY FURNISHINGS AND DECORATIONS IN CHURCHES OF THE RHINELAND - REFLECTIONS ON THE INVESTIGATION OF A SPECIFIC CULTURAL PHENOMENON WITH SPECIAL ATTENTION TO THE TECHNOLOGICAL ASPECTS OF POLYCHROMIES

Gerda Kaltenbruner

Last year the office of the "Landeskonservator Rheinland" in Bonn applied to the Volkswagen Foundation for a research project on the inventory and investigation of church furnishings and decorations in the Rhineland in the late 19th and early 2oth centuries.
The present-day significance of the project arises from the direct danger to which these complex works of art are exposed. Following the serious losses sustained as a result of war-time destruction, the disinterest and devaluation of these documents of cultural history in the post-war years led to further destruction and falsification - not least as a result of purist trends in the official doctrine on the protection of historical monuments.
At present neither the actual extent of the remaining furnishings is known nor is there any approximately clear idea as to their original appearance.
As a 'pilot-project' the furnishing of a neo-gothic parish-church in the Lower-Rhine area has been investigated under both art-historical and technological aspects. Out of this complex the technology of the polychromy of one altarpiece is discussed. As a model this work of art can point out what various materials and techniques were available to artists and craftsmen for the revival of traditional art forms.

The historical and cultural situation in the Rhineland

The subjects of the project are buildings belonging to the historicism group, as a rule in the ne-gothic and/or neo-romanesque style, the overall planning and execution of which were reflected not least in their rich and high quality furnishings.

They testify to the extensive artistic activity of this epoch which produced many "Gesamtkunstwerke" which, in the meantime, have become rarities in the cultural heritage of the Rhineland.

Among the various historicizing styles of buildings, the neo-gothic experienced a tremendous upsurge in the Rhineland around the middle of the century: the completion of Cologne Cathedral and the revival of the cathedral workshop responsible for this work being of

considerable importance in this connection. One need only mention the influence of the cathedral architects Zwirner, Statz and Fr. von Schmidt. (1) In thus turning to the(neo-) gothic which, "in fruitful misunderstanding was interpreted as 'old German'", the profound conflict between church and state, between the spiritual hierarchy and Prussian authority was manifested in the latter years of the century (2).In the Catholic Rhineland among others numerous baroque alterations to older buildings fell victim to this movement (romanesque revival, gothic revival). On the other hand we owe to it the emergence of extravagantly conceived "Gesamtkunstwerke". The furnishings and decorations were mostly, even in the details,based on the architect's plans. For numerous artists and craftsmen, however, the "rediscovery" of their own neo-gothic forms only often came about as a result of restoration work on prominent older works of art. And so the "grown ensembles" in which prefigured medieval forms were adopted and continued are confronted on the other side by genuine new creations on the basis of this language of form.(2)

The present-day significance of the research project

It is in the very complexity of these furnishings and decorations that their increased vulnerability lies. Here, a few brief observations based on practical experience in the protection of historical monuments. In many neo-gothic churches rich mural paintings are characteristic and they often imitate brocade and damask wall hangings on the lower parts of the walls. Here there is often a direct relation to the furniture both as regards colour and form: e.g. the upper limitation of the surrounding curtain-imitating painting is based on the height of the mostly monochrome darkly glazed porches and confessionals; altar-pieces merge into the fabric-imitating paintings of their backgrounds; larger (stippled) patterns are symmetrical to the altar outline whilst the ornamental carvings of the retable decoration are continued in the painted, intertwined tendrils. The design of the floor can repeat elements from walls and windows. Very often the standing position of the furnishings (especially of the pews) is stressed in the drawing of the floor, or the location of the floor tiles ist oriented to them. It is only through this complex decoration of the interior that a context is acquired between the individual furnishings, and that their value as part of the entire interior ist pointed out.
It is obvious that any interference can severely impair the substance of this structure and that the alteration of single objects or their removal, even, often causes a chain reaction. Thus the trend towards the "brighte-

ning" of the mural paintings often results of the wartime loss of the stained glass windows, the consequence of which may be the removal of now irrelevant furnishings.
One aim of this research project is to counteract a further endangering, not least by the creation of a public awareness of these "Gesamtkunstwerke".
A basic pre-condition for this will be the exploration of the material state of the substance.
Very many of the individual objects still have the original wood structure and untouched polychromy. It is here that the special value of these documents lies. At the same time, however, their vulnerability is understandable since, in addition to the extensive ignorance of the technological properties, there is also a lack of experience in the field of conservation and restoration. For it is only a profound knowledge of the original manifestation, of the used materials and applied techniques as well as of their specific aging symptoms that correct interpretations and thus adequate measures are possible.

Plan of Execution

The project is to be carried out in joint work by art historian, restorer, and specialised scientist. The initial inventory listing all preserved objects, that is to say also those that became fragmented through later action, is to form the foundation for all further investigations in the form of a critically descriptive analysis and also for conservatory and restoratory measures. (1) The photographic documentation will be of great importance. The inventory must also include documents and other source material. Especially from this epoch (i.e. the immediate past) extensive information material is to be expected concerning the scope, organization and artistic tradition of workshops, the coordination of various artists and craftsmen, materials etc.
The selection of the objects based on regional centres shall be confined for the present only to complete furnishings preserved as complete as possible.

Example of the investigation of furnishings-

The Catholic Parish-Church of Aldekerk

A number of neo-gothic/churches complete with furnishings, some of them on quite a lavish scale, have been preserved in the Lower Rhine area.
In this area the church of Aldekerk near Geldern was selected by a team of the Landeskonservator Rhineland as an example for study and documentation. The

neo-gothic furnishings of the late 19th and early 20th centuries are in an almost perfect state of preservation: three polychrome carved altars, confessionals, lighting equipment and liturgical instruments, etc. The exposure last year of the original rich mural paintings under a white overpainting of the 1950s, has restored an original structure here in a most impressive manner.
From this, one object is singled out: on the basis of the documentation of a lateral altar-piece, a few major points in the technological investigation, mainly special features in the polychromy are to be explained reference being made at the same time to similar phenomena on comparable objects. It is not the purpose of this report to submit any final statement on the technology of neo-gothic polychrome objects of this epoch. Rather is it intended to present an individual object, which demonstrates through its distinctiveness what various artistic and manual abilities were incorporated in the imitation, presentation and/or revival of medieval art forms. (3)
Such an object can then form a point of orientation for further study of the development of painting techniques of this epoch. It is only the knowledge of the position and function of this work of art within a larger context that enables a full understanding of its significance to be acquired.

The St. Anne altar-piece. Technology of the polychromy

The altar stands at the head of the left aisle against the wall. Curtain painting in blue-yellow brocade design extends at the side to the entire height of the shrine (4); the soaring decoration of the retable is backed on the wall by painted tendrils and continued by a Tree of Jesse portrayal.
The winged altar is entirely polychromed. The centre section of the shrine is formed by the two large figures of Anne and Mary. They are sorrounded by numerous individual figures on the outside of the shrine and in the retable. The altarpiece comes from the Langenberg workshop in Goch. It was acquired unpolychromed in 1891 at the art exhibition in Münster. Only 20 years later the polychromy was executed by the artist Janssen, Kevelaer. The wings painted on both sides are attributed to the atelier of the artist Fr. Stummel. Only optical surface examinations were carried out, partly with the use of binoculars and under UV rays. Analyses of material and examinations of the cross-sections of the paint layers are planned corresponding to specific questions and problems of interpretation. (5)
As most of the individual figures and many of the

architectural elements are only fixed with dowels or simply glued, often a view of the polychrome technique on the rear and undersides was possible.

The entire altar-piece including predella and mensa as well as all the figures and pictorial panels are of oak. The construction and the way the carved wood surface has been finished are characterized by particular precision on the part of the craftsmen.
Mention must be made here of a special feature in the design of the individual sculptures: the figures of the two saints flanking the altar (6) have been carved from a composite block of squared timbers smoothly glued together. At the bottom of the mostly rectangular plinths, the joints, running diagonally, are visible. On the remaining surface of the figures hardly any joints can be detected. On the other hand the 3 sculptures from the altar retable, although of the same dimension and carving, are round-carved from one piece. On each of the rear sides a radial split pointing to the heart-wood, has occurred, one of which has been closed already before the application of the polychromy. Due to the largely continous polychromy, the treatment of the wood surface is only visible at a few points: where the polychromy ends, in deep undercuttings or in losses of the polychromy. The surface structure of of the wood is, however, often visible through the poly= chromy. -The question arises as to the appearance of the unpolychromed altar-piece and how the surface was structured by the sculptor.
For example, dense irregular punchings with a pointed nail-like tool can be seen. This can be observed firstly on the hardly painted ring of Mary's coronet: it is only by chance that it happens to be visible on the hem of the Christ figure - here, however, in a loss of the strongly levelling chalk ground.
Otherwise it can be followed on polychromed parts: e.g. it appears in the imitation of a brocade fabric where the pattern is created by alternating smooth and rough surfaces. The same punchings also stress small recessed fields like the windows of the pinnacles, etc. These various forms of punching also occur in late medieval models.
At several points these structural forms become visible as the polychrome rests on the wood without any priming: e.g. cerulean-like blue in the windows of the pinnacles and red-glazed mordent-gilding on the brocade curtain over thin yellow ochre.

As a result of similar polychrome techniques the great pore-structure of the oak also remains visible. It is especially effective in the surface appearance of the hair: mainly an oily brownish grey without priming, with Mary and Jesus oil gilding over ochre and thin ground.

On the lateral boards (side planks of the inner altar case) next to the main group, the oil gilding shows a special effect: over the thin ochre underpainting the surface-structure of oak mirrors and veins produces in the gold a pattern of alternating bright and dull effects. The tendency to allow the structures of the wood surface to show through the polychromy could already be observed earlier on works in this area: the almost life-size figure of Magdalena (Collegiate Church, Kleve), made and polychromed by the Stephan brothers in 1847, has, in all polychromed parts, a thin, bright, slightly shiny ground, which serves also as an underpainting for the peculiarly light and pictorially finished polychromy. Here the oak structure has its effect on the entire surface, also in the single layer flesh colours (with powerful brush stroke) and in the mordent-gilded hair.

To what extent aesthetic desire forms the basis for the practices described above and perhaps also the tendency towards a simpler and more rapid build-up of the polychromy, can probably only be ascertained by investigations conducted on a broader scale.

In addition to the above-mentioned oleaginous grounds and/or underpaintings, traditional grounds - with white filler in an aquaeous medium - were also used on the St. Anne altar-piece.
On many parts, both the individual sculptures and architectural elements, however, a medium grey single layer is visible between wood and the whitish ground, presumably "Steingrund".(7)
The mostly moderately thick ground (approx. 1,5mm) of the robe sections and in the level parts of the achitecture shows nearly always fine traces of abrasion by sand paper; small, carved forms (e.g. crockets, ornamental carving work) were probably finished with an especial-ly fine liquid layer, they show a very dense ground, with traces of burst bubbles.
Details like pearls or imitation stones are not done in the ground but are already carved.
With the metal applications, burnished gilding pre=dominates in the robes of the sculptures (always over a reddish-brown bole and powerful chalk ground). It serves almost exclusively as an underlayer for rich sgrafitto patterns. The mordent-gilding is done pre=dominantely on a thin ochre-brown layer. On the architectural elements of the "cavetto" (concave profile), however, a powerful blue single under-layer can be seen. Its function will be subject of further examination. On the entirely mordent-gilded and shellac-style glazed plinths, a narrow craquelure is revealed in which the brownish underpainting becomes visible, in two cases,

however a powerful greenish colour. Also in the case of the blue "underpainted" mordent-gildings, a greenish tint can be seen. In which layer and how these changes came about is not yet known.
In addition to gold leaf, apparently a "gold-paint" was used, applied as a liquid over an ochre underpaint; it was found on finest carved details as curtain fringes etc.
A white metal was applied by a mordent-technique. Here and there a colourless to milky opaque film can be observed, partially it is glazed with red and green (angels' wings).
The striking feature of some glazed parts is a strong alligator-craquelure, similar to drying cracks. In this case again, a thin, blue"underpaint" to the metal-leaf becomes visible.(8)
The sgraffitto-surfaces, always monochrome, cover both the insides and the outsides of most parts of the robes, chiefly in geometrical forms: small sectioned and closely inter-woven patterns are reserved for the smaller surfaces whilst on the larger robe surfaces there are loose and wide scratches in parallel strokes between fairly roughly punched blossoms and tendril forms. All the colours over the gold are single-layer applied with weak brush strokes. Most of the scratches were presumably done with a fine blunt tool, the metal leaf seldom being damaged. All pat-terns, even the larger pattern repeats, are drawn freehand.
Monochrome surfaces on the robes were applied mostly in a single layer over a moderately thick ground.
Among the colours, a remarkable variety of red tints can be seen. The colours have been applied in an opaque as well as in a transparent manner.
In the smaller group of blue shades a cerulean-like blue predominates alongside blends of "ultramarine" and a dark "prussian blue".(9)
The only green that appears is a powerful yellowish green with its darker shadings.
Black and white are represented in'pure' colour. As a mixed colour a strong violet occurs, always used in aqueous medium. Many colours seem to be used in aqueous and watersoluble media as well as in oleaginous media.
We thus find that the "cerulean blue" appears on the one hand matt in sgraffitto over gold (robe lining of the angels) and on the other hand in oleaginous medium with a slightly shiny surface (as the basic colour of the surrounding concave profile of the vaults of the inner altar-case, interspersed with gold ribs).

Coatings, Varnishes.
When examined under ultraviolet light, a special technique became visible whereby surface and shade of a colour are varied: some of the sgraffitto-surfaces (e.g. coat lining of Mary and Anna) reveal a yellowish-white re-flecting coating with hardly any brush stroke,giving

the colour luminosity and gloss. In places where this coating did not happen to be applied, e.g. in the depths of the folds, the watersoluble paint layer becomes visible. This coating is colourless and not water-soluble and, under ultraviolet light shows accumulations of small circular spots (dried bubbles?). In most cases it is applied over the sgraffitto. On one surface however, it could be seen that there is a coating showing very similar flourescence between the burnished gilding and the paint layer.(Ultramarineblue coat-lining / Mary.) Only under UV-rays this film becomes visible in the scratches of the colour. Whether it served to isolate the water-sensitive gilding or whether it was intended for the better adhesion of the paint layer is yet questionable.(10) The same "spotty" coating is also to be found over the gilded hems of the robes and gives many elements in the mordent-gilding of the architectural parts a special gloss. In the flesh-colours this "coating" is to be found between the very bright under-painting and the final greyish-pink glaze. Where this water-soluble glaze is missing or has been re=moved, the underpainting with its very lustrous surface-film becomes visible. A fine, net-like craquelure is pre=sumabely due to this colourless coating.
Examination under UV-light clearly reveals another coating with a strong, orange-red flourescence similar to that of shellac. It is mostly dense, without structure. In ordinary light it has a medium surface lustre and a brownish-yellow colouring.
The coloured coating can be seen chiefly on the mordent-gilding of the hair and plinths of the individual figures. In the detailed carving work of the architectural elements the coloured coating often alternates with the colourless. Here, especially the protruding surfaces are emphasized by the glossy colourless varnish whereas inside surfaces and concave forms bear mostly the coloured, less glossy coating. In the robe hems of all the larger figures the broad, finely punched area of decorative inscription was accentuated by a reddish-brown glaze before the final coating.
Finally a particular observation must be mentioned in this context, that is to say in connection with the pro=cedures of surface variation. It concerns the imitation of a patina by pictorial means, a phenomenon to be ob=served again and again on art works of this particular epoch. In this case it is in the carnations the attempt to tone down the colour in order to simulate dirt. In the bright coloured robes a partial film produces an effect similar to that of dust deposit or yellowing in the depths of the folds. Further examination and scientific analyses are continued here.

Remarks on specific alterations to polychrome sculptures

It is obvious that such a complex combination of materials is extremely vulnerable and shows specific alterations, some of which also deviate from the traditional. As the polychromies in most cases are the originals, measures are designed primarily for their conservation and surface treatment. It often happens, however, that even just the cleaning of a soiled surface proves extremely difficult. Moisture-sensitive glazes and artificial patina are often difficult to distinguish from natural dirt. And misinterpretations here can have serious consequences. Frequently conservatory measures, as in the event of loss of adhesion of the polychromy render difficult, because of the often skin-like and still coherent paint layer.
Moreover, in the fixation as well as in the application of a possible final protective coating, the familiar problem arises of how to prevent changes to the original surface effects.
Some forms of alteration mostly caused by the nature of the materials, may seriously disturb the balance of colour and shape. However, they are often irreversible. In the case of oleaginous gildings, for example whole surfaces often have a green discoloration; sometimes only the underpaint is affected which then becomes visible in cracks in the metal. The causes of these colour changes have not yet been established, It is possible that cuprous siccatives in the mordant or parts of the alloy of the metal leaf have something to do with it.

In many colours broad alligator cracking can repeatedly be observed, the different coloured craquelure of which can have a disturbing effect.

Notes

(1) H.P. Hilger, Begründung des Forschungsprojektes "Innenausstattungen des späten 19. und beginnenden 2o.Jahrhunderts in kirchlichen und profanen Bauren des Rheinlandes" im Antrag an die Stiftung Volks= wagenwerk, Bonn, März 1977.

(2) P. Bloch, Skulpturen des 19.Jhs. im Rheinland, Pädagogischer Verlag Schwann, Düsseldorf, 1975.

(3) J.R.J. van Asperen de Boer, A scientific examination of some 19th-century Dutch Gothic Revival polychrom= ed sculptures, ICOM - Committee for Conservation, Beitrag 75/6/7, 4th Triennial Meeting, Venice 1975.

(4) Measures: height of mensa 1 m, predella 40 cm, altar-case 1.95 m; width of closed case 1.80 m.

(5) Scientific analyses by J.R.J. van Asperen de Boer/ Amsterdam, have started early in March'78: 6 samples of paint-layers were taken - first results of the examination of the cross-sections could be included in this paper, they will be completed in further collaboration.

(6) Height of the sculptures 65 cm, width 25 cm in average.

(7) According to T. Brachert,Die Techniken der poly= chromierten Holzskulptur I., Maltechnik 3/1972, S 167, this grey, rather hard chalk-pigment was used since about the 18.th.-century, mainly for gilders' grounds.

(8) Cross-sections of first samples clearly show the white-metal leaf with a colourless transparent film, and a greenish glaze on top. Also a blue under-layer of the metal appears; still the possibility of a pentiment cannot be excluded.

(9) Analyses of the samples identified cerulean blue and synthetic ultramarine as pigments.

(10) Cross-section of the sample shows: whithish ground; thin, reddish-brown bole; metal leaf; transparent film; paint layer with synthetic ultramarine.

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THE SCULPTURE IN MAGUEY, DOUGH AND GLUED CLOTH IN THE HIGHLANDS OF PERU AND BOLIVIA

P. Querejazu Leyton

Abstract

Here is described a particular technique of sculpture,in the area of Bolivia and Peru, the materials used, with - special attention to the maguey, dough and glued cloth, the main components, and the technical procedures used. The creation of the technique at the begining of the co- lonial period (1532-1825), the developments, variants im provements and fathing of the technique pressed by the - needs, the fashion and the popular liking.

I. INTRODUCTION

There are some works that study and explain the techniques of the spanish polychromed sculpture (1) but there is - little on the techniques of the sculpture in Latin America.

I do not intend to fill the gap with this work but only to explain the ways of execution of a particular technique as is this of sculpture in maguey (2) and glued - cloth (3). (Fig.1)

I believe that it is very important to do a - search of the documents that explain those techniques of execution, together with the study - of the pieces, because they will show us, the problems that faced the sculptors in ancient times, and their solutions so we will be able to - know the material problems of the pieces in order to con

serv and restore them in the proper ways, for the future as documents of the past, fo the human doing, thinking and behaving in times that preceded to us, and that give us an identity in which to be ourselves today and tomorrow, in a time of fast and radical changes and lost of identity as is the one we are living in.

The Spanish Sculpture.-

It is obvious that the Latin American sculpture of the colonial period, has its roots in Spain. The spanish, within the european entourage, and by reasons already studied, always prefered the sculpture in carved wood and polychromed. This is the art that they brought with them and the one that with variants was used in Latin America. This art was brought not only as liking but during the XVI and XVII centuries, large quantities of sculptures were imported to America from Spain (4) and some sculptors arrived from the mother-land, executed and taught their art and skills (5).

The prehispanic sculpture.-

The prehispanic sculpture had a great development in varieus techniques, specially in cultures preceding the Inca civilization and with full mastery and skill over all the materials used for it.

There have been a lot of talk about the influence of the prehispanic sculpture on the colonial sculpture, just about the matter of the maguey and glued cloth (6), but it is quite difficult to mesure the reach of that influence.

In fact there was a type of prehispanic sculpture that could resemble and be comparable to the colonial one of maguey and cloth; this type of sculpture is called "muñeca" (Doll). It consists of a small piece of wood carved representing a nude human body, that was covered with small dresses. Sometimes, the body could be done in boone, stone (7), ceramics and in later times in metal. There is not a single example of such a body made on maguey. These dolls had a concrete religious meaning and were to be dressed in special oportunities. But the fact is too, that those dolls were common in a period of time that goes from 2,000 - 1,000 years before Christ, called "Formative period" and later they became rare pieces; specially during the Inca civilization and empire, they were

almost forbidden, because the Incas for some obscure rea sen did not like to represent the human figure.

So the only probable conexion between the prehispanic - dolls and the colonial sculpture of maguey and cloth,has a gap of about one thousand years (8).

II. THE SCULPTURE DURING THE REINAISSANCE AND MANIERISM (1532-1630)

The first years.- In the Viceroyalty of Peru (today Peru and Bolivia) the blossoming of the arts began when the period of the conquest was over (around - 1570) and when the administration of the Viceroyalty was implemented by the Viceroy Don Francisco de Toledo. During the war of conquest and the first civil war, there was a gap in the authority and administration that began with the arrival of the spaniards to Cusco in 1532 and the - fall of the inca empire and that ended with the adminis-tration of the Viceroy Toledo. During this period the - prehispanic pagan temples were adapted to the Catholic - cult and it was in that very moment that the spanish - should have done sculptures and paintings, very quickly, to fill the most rudimentary religious needs of the con-querors and to substitute the images of the pagan cult. It is in that moment that the technique of the glued cloth was used, (and later included the maguey), because it was easy to use and required very short time to finish the - pieces, and the maguey unknown to the europeans was in-- corporated because it is light, soft, easy to work;these rudimentary sculptures should have been changed later, - once the administration of the viceroyalty was implement ed (1570), by new sculptures of better quality executed locally, or in some cases by pieces brought from Spain.

It is in these first years that the fundamentals of the techniques of maguey and glued cloth, were laid down,and of which there are rare examples only. From this period is the "Cristo de las Animas" (Christ of the Souls) in - the altarpiece of the "Lord of the Affliction", in El - Triunfo, Cusco (Fig.2). In fact the technical procedure and specially the finishing, talk about a quick work,and a stylistic study shows, the characteristic shape of the late gotic and early renaissance, with long arms, the - ochre color of the carnation and the lack of realism.The sculptor made a manikin of straw over which he applied - wide stripes of cloth soaked in glue, when the glue dried

out, he took off the straw, then assembled the hollow parts of the body;to reinforce the arms,he carved the hands and glued them to a pair of rods that support the wrist and go up to the elbow; then covered again the figure with new stripes of cloth soaked in glue but taking more care in the modelling. When dry the cloth was covered with several coats of priming. The crown of thorns was made with a thin rope soaked in glue

then weaved holding the thorns made from the bark of the maguey, when all the crown dried, received some coats of glue and gypsum and was polychromed.

The figure of Christ is fixed to the cross with nails of copper. The cross is of alder wood and painted dark brown The polychromy is coarse, applied in a hurry without any interest in achieving delicate effects, even shows spouting. The general color is ochre.

The last third of the XVI and the first third of the XVII Centuries.- In this period the need to decorate the new churches hurriedly constructed, put a pressure for a fast work to the just arriving spanish sculptors who skilled in carving and polychroming, some times had to switch to the technique of cloth and maguey.

An image of this period executed in maguey and cloth, is the "Señor de los Temblores" (Lord of the Earthquaques) of the Cathedral of Cusco. The figure, a crucified Christ was made by a spanish sculptor circa 1570. The proces of execution was as follows: the sculptor prepeared a manikin of straw, over the manikin put wide stripes of cloth soaked in glue, when the cloth was dried, took off the straw puppet, remaining a hollow body, and head, and reinforced the interior part of it and the legs with little rods of wood fixed with dough; the arms were reinforced with long wood rods that go from the hands to the -

center in the trunk of the body. Then joined the parts of the body with new stripes of cloth soaked in glue. - Over the bulk of the figure the sculptor modelled the de tails of the Christ, gluing pieces of maguey cut in small plaques to the body and then carved them. Over it were applied several coatings of priming. The small details as the blood spouts and beard were made with dough. The hands, feet, and the hair of the head were made of carved maguey and they are not hollow. The pudicity drapery was made with a thin cloth, soaked in glue, with a great knot on the left hip.

The polychromy is mostly incarnation and it is a yellow-eish-ochre tone as in the Christ previously described, - but in this case, it was carefully applied, and even has gilding in the pudicity drapery. The figure is nailed to the alder-wood cross with gilded nails of iron, the cross is painted of green, and gilded in the edges (The Christ and his cross look now almost black due to the accumulation of smoke caused by four centuries of candles lighted to this image).

This technique becomes of common use because it was quite easy to get maguey (not so cedar-wood that was used - specially for altarpieces) the light weight of the sculpture the short times of execution and low costs. The common sculpture was made using the maguey as base, and covering the final figure with cloth (not hollow as in the Christ described) and the final details made with dough.

As the years go on and the administration begins to bear fruits the sculptors carve sculptures in cedar-wood (9), made altarpieces, choir stalls and the like, as is the - profet (circa 1580) of Gómez Hernández Galván in the Regional Museum of History in Cusco.

A document of the period shows clearly the quality required in the finishing. It is the contract of Juan Ponce to gild the altarpiece of the Virgin of the Mercy, in Cusco, in 1581, that in a part says: (10) "Item, todos los rostros y pies y manos de imagenes y medallas y serafines an de ser encarnados y de pulimento, con sus diferencias de colores conforme las edades y figuras, y abiertos los ojos y cejas, y refrescando de buenos colores las demás partes de los rostros de manera que los oficiales que lo vieren lo den por buena obra y bien acabada y con colores finos de castilla asi asul como esmaltes y cenysas, geno-

lis (11), emborla (12), bernicés y todos los colores". (Item, all the faces hands and feet of images and medaillons and seraphs will be incarnated and burnished with its differences of colours according the ages and the figures, and the eyes opened and eye brows, and refreshing with good colours the remaining parts of the faces, so - that the officers that would survey it aprouve it as good and well finished work, and with fine colours from Castillia (Spain), so blue, as enamels and ashes, genolis(11) emberla (12), and all the colours..)

In the last decades of the century, Bernardo Bitti and - Pedro de Vargas, both jesuits were working in this technique the reliefs of the main retable of the Church of - "The Transfiguration" in Cuzco,(13)"Los tableros entre si estaban unidos con cola animal y encima y por delante y detrás de las uniones se pegaron unas bandas de tela - de lino, para reforzarlas. Por la cara anterior de los tableros, bien cepillados, se pegaron los fragmentos de Maguey que dan cuerpo al relieve. El maguey ha sido tratado aquí de un modo distinto al usual pues no solamente sirve de cuerpo al relieve, sino que ha sido tallado hasta donde lo permite la calidad de la madera. Normalmente y en tiempos posteriores se deja el maguey en bruto y se hace el acabado final de la talla con pasta de tiza y tallando la pasta una vez seca. Incluso los ropajes son de maguey tallado (y no de tela encolada como es la forma usual). Algunas partes muy delicadas han sido reforzadas con pequeñas bandas de tela fina de lino, tal el - caso de la mano izquierda del Santiago..." (The panels - were joined together with animal glue, and over the joints, by the fron and back side, were glued stripes of - flax canvas to reinforce them. By the face of the panels properly whisked, they glued the pieces of maguey - that make the bulk of the relief. The maguey has been - treated in a way slightly different to the usual, because not only makes the relief of the figure, but has beem carved to its limits. Normally and in later periods the - maguey is only partially carved, modelling the final details with a dough of glue and chalk, carving the dry dough Even the clothes of the figures are of carved maguey (and not with glued cloth as is the usual way). Some parts - that are very fragile, were reinforced with small stripes of thin flax canvas, as is the case of the left hand of - "Saint James"..."). The reliefs of the Asunción in Juli, and the retables of Acora and Challapampa made by -

Bitti, were executed in the same way. This procedure - to work reliefs became general for altarpieces.

Due to the fact that in the polychromed sculpture in Spa in there is almost not an example in which was used the glued cloth, and that in the highlands of Bolivia and Pe ru this was a common use, people began to say that it was a Prehispanic contribution to the sculpture. As explain ed in the introduction, there is not any proof yet that- the sculpture of maguey and glued cloth was used as that in the prehispanic period. By the other side it was not an enterely european technique, so I could say that it - was developed during the viceroyal period, and in this - sense the techinique is an american contribution to the- art of sculpture. About the maguey, there is not any - doubt that it is american and that it was not known in - Europe.

About the glued cloth, its use was known by the spanish artists (14) who did not use it for the execution of de- finitive works, but for making models, that later trans- lated to other materials like carved wood, brass, marble (In this way the sculptors prepeared structures of wood, ropes, and even straw manikins, over what was placed the cloth, some times soaked in glue, so that after drying - became hard). I believe that the spanish sculptors - that came to America and to this region, knew all this - procedures, and even they taught them to the natives.(15)

About the dough, it was used widely and profusely for fi nishing before the priming and polychromy, and could be- prepeared in two ways. In a contract of 1612 with Fran- cisco de la Cueva (16) says: "..se an de echar unos sera fines de pasta y se an de dorar..."(..some seraphs of do ugh will be done and gilded...).

The basic components of the first type were gypsum (17) and animal glue. The glue was obtained from animal skin (18). They incloded to the dough bile of cow, because it is an excelent humective agent. They added flour too - and was prepeared as a starch paste with boiling water,- the glue was added to the paste and then the gypsum with the adecuate quantity of water, then, the dough was rea- dy. Some times they added ashes or coal to get a gray dough. In a contract of 1623 we found the following - description: (19) "La talla será de cedro y las figuras de relieve, de pasta amasada de yeso carbón y hiel de va ca y harina..."(The carving will be of cedar wood and

the figures in relief with a stired dough of gypsum coal and bile of cow and flour..). This dough was used mostly during the XVII and XVIII centuries.

The second type of dough was made of saw dust and was prepeared as fellows: They melted the glue and when ready, added in which had previously boiled garlic, because of its fixing properties, then added the sawdust and the dough was ready. This type of dough was used mostly during the Renaissance and Manierism. (see note 25).

The cloth used could be any one, but in general during this period we find that the sculptors used canvas of flax or hemp (20) brought from Spain. In a contract dated in 1573, between Diego Ortiz, spanish sculpter and Andres de Estrada, when contracting the execution of a Crucified Christ says: (21)"Crucifijo de Bulto, de estatura de un hombre poco mas o menos...", "por hechura de lo cual el dicho Andrés de Estrada le ha de dar y pagar (to Diego Ortiz)cien pesos de plata corriente y además el rusn(22) y cañamaso (23) que fuere necesario para ello and the sculptor would give it finished "... de mes y medio desde el dia que le comenzare..." (Crucifix of bulk of the height of a man more or less", "..by which the mentioned Andrés de Estrada is going to give and pay him one hundred pesos of ordinary silver and even the rusn (22) and cañamaso (23) necessary for that...", "..in one month and a half from the date he would begin it..."). In the seventeenth century we find that the sculpters commonly used wool cloths from worn out native dresses.

The cedar was used since the begining because of its quality specially to make the bases, dowels and rods that supported the maguey in the sculptures; the alder was widely used too. They executed the base pedestal in one of those woods including the rods, then they worked the general anatomy of the figure with the peeled maguey, cutting pieces of it to a determinated shape, then the pieces were glued together with glue, and to reinforce the structure; the pieces were nailed with nails made from the maguey stringy bark, and tied up with ropes. This general shape of the figure was then modelled with a dough made with sawdust and glue doing with it the final shape of the sculpture up to the most delicate details. In some parts, known to be easy to break as fingers, the pieces of maguey were covered with stripes of thin cloth soaked in warm glue. Then in the cases in which the -

sculpture was a dressed ima ge, it was co vered and dre ssed with the cloth presoa- ked in glue. When the glue dried, the cloth became hard and streg Then all the sculpture was covered with several coatings of gypsum and size as priming for the polychromy and gilding. (figure 3).

III - THE SCULPTURE DURING THE BARROQUE. (1630 - 1700)
During this period of time we did not find any techni- cal improvement of importance, and only some variants - in the technique and documents informin about the execu- tion of sculptures, because the technique was already es tablished in the preceding period. We only find that - the wool cloth became more common and more widely used - but without excluding the flax or hemp.

In this period, due to the influence of the sculptors - specialized in carving, that criss-cross the region, spe cially between Cusco and Potosí, the local sculptors im- prove their skills in carving, and do part of their work in cedar. Martin de Torres is the sculptor of the ima- ges of the Holy Trinity in the retable of the same name in the Cathedral of Cusco, as it is said in a part of - the contract: (24) "..todo el retablo entero de madera - de cedro colorado y bueno y enjuto y de la misma manera hará una imagen de la Santísima Trinidad de escultura de la estatura del dicho Martín de Torres...", ("all the re table of good and dry red cedar wood, and in the same - wood he will do an image of the Holy Trinity in sculpture of the same height of the mentioned Martin de Torres").

The sculptors any way continue doing their work with ma- guey and cloth, and in cases with some variants, as is - the one made by Esteban Alvarez in 1696, in the retable for the parrish church of Chamaca (Cusco), as described in the document: (25)"..la cabeza y manos de madera y los cuerpos de aserrín de cedro...",("..the heads and hands -

in wood, and the bodies of saw dust of cedar..."). At - the end of this period begam to apear processional ima - ges to be dressed.

IV - THE MESTIZO BARROQUE AND THE REALISM. (XVIII Cent)

In Spain, in the last thirth of the XVII century, after the classic style of great masters like Martinez-Montañes, Mesa and Hernandez, the art begam to decrease in - technical quality, specially with the work of the Roldán family in Sevilla, and went towards the super-realism in which the sculptors used many tricks to achieve efects - of realism, and the most used efects, were the fashion - of dressing the images with real cloths, put eyes of glass wigs, beards and eyelashes.

This fashion of sculpture reached the highlands of Bolivi a and Perú in the last years of the XVII century and was spreaded during the XVIII century.

An example of this fashion in the period is the image of Saint Christoffer in the Parrish church of San Cristòbal, in Cuz co; sculpture atributed to the indian sculptor Félipe Huamán - Maita. (Fig.4). This piece, as most of this period, has a base made of alder, supported two big rods that go through the legs - to the neck of the Saint are - supported in this base.Around - these bars were glued the pie-- ces of maguey, and nailed with nails of bark of maguey, and - tied up with thin ropes made - with fibres obtained from the - Leaves of the same maguey. In - that way the general volume of the sculpture is shaped, then,- over the maguey, is the glued - cloth, forming the dress of the figure. The sculptor made the final modelling of the legs, - feet, arms and hands, with a dough of gypsum. It is not common to find cloth in the parts, as face, hands, feet, or any other to be incarnated. The cloth is of worn nati ve dresses, made of wool, and still conserv the original dyes typical in those dresses. In some cases, the cloths

were worn out priests'habits.

The real improvments in respect to the previous periods were: puting nails in the fingers, that usually were ma de of a thin piece of horn, thin enough to be translu-- cent, and even they cared for the detail of painting - dirt in the edge of the nails.

From this period on, the fa ces were made in a mask of dough (Fig.5) carved by the back side, to allow placing eyes of glass, teeth, tonge and even a small mirror in the throat. The eyes were - made from melted glass, spi lled on a small bowl carved in a stone, the stone had - to be warm, they rocked the stone, until the glass took the shape of the bowl, the eyeball of glass was ready when it cooled down and be- came solid, the sculptor - painted the details of the eye in the interior of the eyeball of glass, then it - was placed in the mask and fixed there (26).

In some cases the teeth were not carved, but they were natural ones (from animals in Saint Christoffer). Then, the mask was put in its place, and attached to the head with thorns made of maguey bark, glue, and dough. Once the head was complete they shaped in fresh dough the - hair and beard. At the begining of the century the sculp tor made the hair shaping it with their hands and some instruments, later they were made by casting the fresh dough. If the image needed tears, they were made approa ching a small piece of glass to the fire, when this be- gan to melt and made a long tear drop it was inmediate- ly attached to the face, without any glue (after the fa ce had been polychromed).

Sometimes, when the sculpture was of particular impor-- tance, the sculptor did not make the hair in dough, but he prepeared a wig. The top wigs were made from natural hair of women. The hair was attached and sewed to a cap

que of cloth. Once the wig was ready, it was soaked for a time in fermented urine, to improve the shine and blacken the hair, then when dried it was soaked again in water with a light amount of gum, for a permanent combing and curling of the hair. Then it was placed on the head. In some cases the same procedure was used to prepeare a natural beard for a Christ or a Saint.

The eye-lashes were executed from a small lock of hair; the lock was tied from an end the other end was spreaded regulary, like a fan, the exterior part of the fan was cut in a semi-circle, and the interior part was sewed to a support of paper or leather like modern false-eye-lashes; then, they were attached to the eye lids.

In respect to the body of the images that were to be dressed, the sculpter executed a very sober body of the image and covered it with glued-cloth, when dry, it was primed and painted with a purplish or bluish color, with water and glue. Covering this bulk were the clothes or dresses of the image. The feet or shoes of the image, were made in dough. The arms were made in the same way that in previous periods. The hands were made completely in dough (without the support of maguey, common in earlier times). (Fig.6).

There was a type of image for dressing, that was called of "candle-stick". In which the body was a trypod of maguey, or sometimes a hollow cone of wood covered with leather, with handles in the base. The torso was a bulk of maguey and with a dowel in the neck where the head was placed. The arms were flexible, they had articulations of cloth filled with wool, in the elbows and shoulders (27). Late, in this century, there were not great sculptores any more and the works were made by the remaining anonymous workshops that covered the great number of local and abroad orders, executing them, specially for export -

with increasing speed and obviously with decreasing technical and material quality. In some cases the final product was very poor.

V - THE SCULPTURE DURING THE XIX CENTURY

If only the first quarter of this century were under the spanish egis, and the remaining correspond to a politically independient republican period, it could be said that until the half of the century the work was continued in the same cultural forms than in the colonial period. Just from the fourth decade of the century, the aesthetical - forms began to change though not the techniques. A very clear example of this is the sculpture of the "Liberty" from the Palace of the Admiral, in Cuzco (Circa 1830). Such a sculpture has the same technique of execution than the virgins and saints of the colonial period, and the - only change is in the fabric used, which is of a industrial type, very thin, and of a very fine thread (very - common in the canvases of the paintings of this period). The remaining changes are in the iconography, because - instead of the mantle, the sculpture has a toga and tunic of classical Roman style, and instead of a crown has a phrygyan cap, and the colors are cold, according to the neoclassical aesthetics.

The workshops began to extinguish due to the lack of orders, because, though the countries of the area were politically independent, they became economically and culturally dependant from England and France respectively - and began the impartation of italian, french or english sculptures made on brass or marble, that decorated the Gobernment buildings, and the residencies of the high society (but not the churches or houses of common people).

Though the great workshop of the XVIII century disappeared, some local artisans continued (and still do) working small and popular images (28), with maguey and glued-cloth for dressing, with eyeballs of glass and fixed wigs, example of this is the "Niño Manuel" made in Cuzco. During - this second half of the century, it was (and it is today) common to see the use of paper instead cloth, to make the dresses of the images. Even it became common the use of metal plate of tin or yellow brass, or even lead for some special efects, as wings for the angels, swords, and the like.

VI - THE TOOLS

On the tools it could be said the following. From the 7 observation of the pieces of the XVI and XVII centuries we can see that the sculptors used all of the common - instruments of carpenters, including those for carving. The parts of the pieces, made of cedar or alder are perfectly cut, grinded, trimed and asembled. The parts made on maguey are clearly well cut, and show the use of saws, knives and carving tools. They made full use of - hand saws, frame saws, pad saws, jigsaws, planes, scrubbers, chisels, gouges, scorpers, calipers, grinders, - drillers, and the like.

But since this is a technique that includes dough and - cloth, a great part of the work was rather more modelling than carving. In this sense we noticed the used of putty knives and even the very hands of the sculptor, - for modelling the fresh dough and the still wet cloth.

During the XVIII century, becomes evident a decrease in the use of the previously mentioned instruments and a - less care for the treatmen of the maguey and wood, the former was cut only with knives and even with broad axes cutlasses and hatchets; the knives were arranged in different shapes to fit the particular needs of each sculptor. The putty knives become more commonly used and - were prepeared by each sculptor, specially for the work in the masks, hair and beards of the images.

VII - CONCLUSION

I believe that in this way I have shown a detailled view of this particular technique of sculpture that is common in the highlands of Peru and Bolivia with centers in Cuzco, La Paz, Potosí and Chuquisaca (Sucre), technique that represents the finding and development of a solution for special problems and needs, and that became of wide spread due to the great demand and consecuent quantity of sculptures that were exported specially from Cuzco and that, reached Ecuador, by the North, and Santiago de Chile, the North of Argentine and the whole Audiencia de Charcas - (today Bolivia) by the South and became artisanal procedures of universal use that even today are practiced by the artisans in various parts with some variations but with a great technical fidelity.

N O T E S

(1) SANCHEZ-MEZA MARTIN, Domingo. "Técnicas de la Escultura Policromada Granadina". University of Granada.1971. See also: GOMEZ MORENO, María Elena "La Policromía en la escultura española". PACHECO,Francisco. "El Arte de la Pintura". Thirth Book, Chapter VII. "About the gilding burnish and mate on various materials". Sevilla, 1649.

(2) COBO, Bernabé. "Historia del Nuevo Mundo".1653, Volume I In "Biblioteca de Autores Españoles". Volume LXXXXI. Madrid, 1956. Pag. 211. (The following transcription has been translated by the author, from the original in ancient Spanish): "The generical name of maguey is atributed to a certain type of it, which it is the most common and from which is obtained the hemp of the country. It is a bush shrub of the saize of the aloes, that has a lot of leaves around it, all born from the trunck at ground level, that are thin, and meager, stringy, chaneled, of a dark green, with thorns at the edges... The stalk is straight and sleek and after dried, whitty and light, like a gossip. It has a hard bark, which is that give strenght to the stem, slightly thicker than a finger, all the remaining the heart, white, soft,spongy and light"; and ads: "the heart is useful to the sculptors because from it they do images of bulk very perfect and light".
Cobo also mentiones the fact that the maguey (the stalk) was used by the natives for the structure of the roof of the houses. This use passed to the spanish in the colonial period, and we could see it today in use in the rural areas for the same purpose.
The maguey is a type of agave. It is a common sight today, in the high valleys, at the borders of the roads, serving as fences, because of its thorns. The stalk is 4 to 6 meters tall, has to be cut, freed from its flowers and let to dry.
The sculptors peeled the stalk and used the heart for the sculptures, they made nails from the stringy and hard bark, the spanish sculptors adopted it from the begining, for its light weight, ease of obtainment,ease of work and low cost.
Its quechua name is "chuchau", and in Aimara it is "tuuca".

(3) The fabric used for the sculptures was always a cloth. I did not find a single twill weaving.

(4) DE MESA, José and GISBERT, Teresa. "Escultura Virreinal en Bolivia". La Paz, 1972. pag. 30.

(5) DE MESA - GISBERT. Op.Cit. Pages 36,42,51,63 and 66.

(6) DE MESA - GISBERT. Op.Cit. Page 23.

(7) VALENCIA ZEGARRA, Alfredo. "Las Micro Esculturas de Saqsayhuaman". SAQSAYHUAMAN No.1, page 159. Cusco. July 1970.

(8) I reached to this conclusion after several consultations with archaeologists in Lima and Cuzco, like Dr. Luis Lumbreras and Dr. Alfredo Valencia, and examining the colections of the National Museum of Antropology in Lima, and the Archaeological Museum in Cuzco.

(9) COBO, Bernabé. Op.Cit. Pages 279-280. (The following - transcription has been translated by the author, from the original in ancient Spanish). "The tree that the spanish call cedar in this country, differs in species from the cedar described by the ancient (greeks and romans); but they (the spanish) have given this name for its precious wood. The tree is very big, bigger than a walnut, thick-topped and of agreable looking. Those trees grow in large quantities in all the warm and hot lands of this New world though with this diference: the wood of the tree of warm lands is white, and the wood of tree of hot lands is red, which is the one that is brought to this kingdom of Peru, from Mainland, Nicaragua (Central America) and other parts and is quite better than the white wood, it is bitter to the taste and fragrant. They work in cedar all the curious and durable things that are done in this country, as are the retables for the temples, saints of bulk, panelled - ceilings, desks, coffers and other thousand things and - even whole vessels are made throughly with cedar and are quite light". Ads in other part: "this wood is, as the - carpenters say the best available for carving and is very neat for doing with it every work and figure".
See also: "Cedar".
GETTENS, Rutherford J. and STOUT, George L. "Painting Materials". New York 1966. Pages 224-225.

(10) CORNEJO BOURONCLE, Jorge. "Derroteros del Arte Cuzqueño" Cuzco 1960. Page 161. Contract for gilding the altarpiece of the Virgin of the Mercy. Juan Ponce gilding master. 21-VII-1581 (Cornejo transcribed the contract with mistakes. It has been fully reviewed by Laura Escobari).

(11) Ibid.

(12) Orpiment. Also know in those times in Spanish as "oropimente" "jenuli" "talde".

(13) QUERRJAZU, Pedro. "Sobre cinco relieves de Bitti y Vargas en el Museo Histórico Regional del Cuzco". Arte y Arqueología 3 y 4. La Paz 1975. Page 109. (Translated from the Spanish).

(14) RIBERA, Adolfo Luis and SCHENONE, Héctor. "El Arte de la Imaginería en el Río de la Plata". Buenos Aires, 1948. Page, 115.

(15) MESA and GISBERT, in their book mentioned in note (4) pag. 259, included the autobiography of Francisco Tito Yupanqui, native sculptor, who describes how he was taught in 1581, the art of sculpture, in Potosí, by the spanish - sculptor Diego Ortiz (mentioned in note 21 later in this work).

(16) "Contract for the grate of the Upper Chorus, between the Monastry of Saint Catherine of Cuzco, and Francisco de - la Cueva, Carpenter". 30-VIII-1612. F.162. Legajo 14 from the "Papers of the Foundation of this Monastry of Saint Catherine". Unpublished document supplied by Laura Escobari.

(17) The sculptors used two types of gypsum for their work. - The first one, YESO (today called Yeso de París) is a - coarse burned gypsum (plaster of Paris) that was mixed with animal glue for the preparation of the dough. The - second one, was called YESO MATE MUERTO and was a fine - gypsum hydratated during several days, and was used the priming, mixed with size.
See also:
GETTENS & STOUT. Op. Cit. "Gesso", page 115; "Gypsum", pages 117-118.

(18) The sculptors used glue for the preparation of the dough and for soaking the cloth, and used size for priming. See also: GETTENS & STOUT. Op.Cit. Pages 25-26 and 62.

(19) CORNEJO BOURONCLE, Jorge. Op.Cit. Contract between the - Convent of Saint Agustin and Juan Pérez de Villareal and Juan Toledano. 11-V-1623. Page 129.

(20) The fabric used sometimes is made from flax, as found in painting canvases, but many times the fabrics were from the packing of the goods imported from Spain, so it was coarse canvas made of hemp.

(21) DE MESA - GISBERT. Op.Cit. Page 36

(22) Ruan. A kind of cotton fabric. In Spain, in earlier times supposed to come from Rouan, France.

(23) A coarse canvas. Its name is derived from cañamo (hemp)

(24) "Contract for the altarpiece of the Holly Trinity in the Cathedral Church". Martín de Torres. 1657. ff. 572. Protocolo 658/176... Lorenzo Mesa Andueza. Departamental Archive of Cusco. Second hall. (Document supplied by Laura Escobari. Cornejo Bouroncle in his mentioned book (10) published partially this contract, but omiting the detail described by us).

(25) Contract for the altarpiece and images of the Church of Chamaca (Chumbivilcas-Cusco) Juan Esteban Alvarez 1969. ff. 587. Protocol 499. Fol, 1-1082. Esc. Pedro López de la Cerda. Departamental Archive of Cusco. Unpublished - document supplied by Laura Escobari).

(26) RIVERA - SCHENONE. <u>Op. Cit.</u> Pag. 106.

(27) RIVERA - SCHENONE. <u>Op. Cit.</u> Pag. 115.

(28) RIVERA - SCHENONE. <u>Op. Cit.</u> Pag. 116.

(29) MESA - GISBERT. <u>Op. Cit.</u> Pag. 169.

AN EXAMINATION OF SOME PAINTING MATERIALS OF SEVERAL 15TH CENTURY POLYCHROME SCULPTURES

V.J. Birstein, M.M. Naumova and V.M. Tul'chinsky

This paper presents the results of a physico-chemical and chemical investigation of the pigments, grounds and other painting materials of six polychrome sculptures from the altar of the Church of Holy Spirit in Tallin (Esthonian SSR) performed by the craftsman Bert-Notke in 1483. Samples were taken off the following sculptures: St Olaf, St Anne - figures of the left side shutter; a group with Apostle Peter, St Dorothy - figures of the central composition; St Victor, St Elizabeth - figures of the right-hand shutter.

The principal methods used included an X-ray diffraction analysis and infrared spectroscopy. X-ray diffraction patterns were obtained with "Mars" diffractometer, infrared spectra were recorded with a "Perkin-Elmer 257" (4000-625 cm^{-1}). In the latter case 1,5 mg of sample substance was pressed with 300 mg KBr into pellets.

The paint palette of polychrome sculptures is represented by four colours: white, red, blue, green.

White paint. Lead was discovered in samples by microchemical and emission spectral analysis. The data obtained from the X-ray diffraction analysis (Table 1) made it possible to conclude that the white paint on the sculptures is a mixture of basic carbonate lead white $2PbCO_3 \cdot Pb(OH)_2$ and a small amount of cerussite $PbCO_3$.

A similar conclusion can be made concerning the white overpainting of St Anne's figure. IR-spectra of the samples taken off the upper layer which dates from

1815, (Fig. 1,a) and those of the samples of the underlying layer (Fig. 1,b) are very similar. They represent spectra of mixtures of cerussite (bands at ~ 1405, ~ 840, shoulder at 676 cm^{-1}) and basic lead white (bands at ~ 1405, ~ 1630, 690, 680 cm^{-1}) (1). Basic carbonate content in the first sample is slightly larger than in the second one: the band of stretching vibrations of OH-groups at ~ 3520 cm^{-1} is more clearly seen as well as the band at 1630 cm^{-1} and, especially, at 680 cm^{-1}. Besides, $CaCO_3$ mas found in the mixtures - bands at 3400, 2520, 1800, ~ 1430, 877 and 715 cm^{-1} (2).

Table 1. Debye-Scherrer patterus of the white paint sample

d, Å	Intensity	d, Å	Intensity
4.48	low	2.08	high
3.61	very high	1.99	medium
3.34	medium	1.95	high
3.07	high	1.90	very high
2.63	high	1.71	medium
2.49	high	1.64	high
2.33	low	1.60	high

Blue paint. Transparent dark blue crystals of 10-200 μ with a small admixture of transparent green crystals of 50-100 μ and transparent colourless pieces of 30-50 μ could be seen in the samples under a microscope. The X-ray diffraction analysis proved that the blue crystals were azurites $2CuCO_3 \cdot Cu(OH)_2$, and the green crystals were malachite $CuCO_3 \cdot Cu(OH)_2$. The latter is, evidently present as a natural admixture of natural azurite. The colourless pieces of quartz and mica are likely to be a natural admixture just as well.

Red paint. Two layers of different red pigments were distinctly seen on transverse sections of the red

paint layer under a microscope: the upper layer being thin, glazed and of crimson colour and the lower layer being thick, more dense and consisting of red grains. X-ray diffraction data showed that the underlying pigment was cinnabar.

There was protein in the red paint sample taken off St Victor's shield (Fig. 1,c): bands of Amid I (1650 cm^{-1}) and Amid II (1550 cm^{-1}) were seen in the paint's IR-spectrum. In general, the spectrum is similar to the IR-spectrum of egg white (Fig. 1,d, spectrum of egg white having been aged in ultraviolet rays during 405 hours). It is likely that there is a small amount of admixture of $CaCO_3$ in the paint (bands at 1430 and 875 cm^{-1}), although absorption at 1430 cm^{-1} as well as in the regions of Amid bands and at 1015–1150 cm^{-1} can be explained by the presence of carmino acid (2). The major pigment – cinnabar, identified by means of X-ray diffraction, could not be discovered by IR-spectroscopy (2).

The presence of carmine lake was proved by a solubility reaction (3): the solution turned red when the paint sample was heated with NH_4OH. The presence of protein was also confirmed by thin-layer chromatography on ion-exchange plates "Fixion" (4) of paint hydrolysate (5.7 N HCl, 24 hours, 110°C). The set of amino acids and the intensity of spot colouring were similar to those identified while analysing hydrolysate of egg white.

The data autlined above confirm the conclusion drawn from the investigation of the paint layer's cross-section, namely, that the lower thick layer of the red pigment is cinnabar overlaid with a glazed layer of carmine lake which is probably covered with egg white. Such application of egg white was already

recorded in a study of medieval Norwegian icons (5).

Green paint. Microscopie investigation of the paint layer's cross-section made it possible to determine that it consists of two sub-layers: the lower thin one (~10 μ), directly overlaying the ground and consisting of pale-yellow grains, and the upper one (~50 μ) - with identical pale-yellow grains and greenish-blue crystals (3-10 μ).

Microchemical and emission spectral analysis helped to determine copper, lead and tin in the green paint. The results of X-ray diffraction analysis are given in Table 2;the d spacings of the pigment lead-tin yellow are also given there (6). A comparison of these values makes it possible to conclude that the described pale yellow grains are particles of lead-tin yellow that had been frequently used in mixture with verdigris (7). X-ray diffraction failed to reveal the structure of the copper green pigment.

Table 2. Debye-Scherrer patterns of green paint and lead-tin yellow.

Green paint		Pb_2SnO_4 (6)	
d, Å	Intensity	d, Å	Intensity
3.35	very high	3.35	100
2.78	high	2.77	40
2.55	medium	2.55	15
2.26	low	2.25	20
2.01	low	2.01	50
1.86	high	1.86	70
1.81	medium	1.80	70
1.72	high	1.73	80
1.58	medium	1.57	65

IR-spectrum of the green paint sample taken off St Anne's figure is shown in Fig. 1,e. It is almost identical to that of the green paint from A.Altdorfer's

painting published by H.Kühn (7). It may be assumed that the paint consists of verdigris (bands of stretching vibrations of ionized carboxyl groups at 1550-1620 cm^{-1} are present in the spectrum) and dried-up oil (bands at 1715-1735, 1160, 1245, 1100 cm^{-1}). The band at 1410 cm^{-1} should be attributed to deformation vibrations of CH_2-groups of both verdigris and oil. IR-spectroscopy failed to distinguish lead-tin yellow (6).

It was established that the green paint covers the ground apparently glued with egg white. Thus, a dark layer between the ground and the paint layer was seen on the cross sections of painting samples. A dark film remained after the remoral of paint layer from a small painting fragment taken with the ground and the dissolving of the ground in 1 N HCl. Amid bands at 1640 (Amid I) and 1530 cm^{-1} (Amid II) were clearly seen in the IR-spectrum of this substance while bands of vibrations of carboxyl groups were missing. The distribution of amino acids of the film's hydrolizate on "Fixion" plates and the intensity of amino acids spots were similar to that of egg white hydrolizate. A similar ground treatment by egg white was determined in the case of Norwegian icons (5).

In can be assumed, therefore, that colouring with the green paint was performed by stages. At First painters coated the ground with egg white overlaid by lead-tin yellow which, in its turn, was covered by a layer of verdigris mixed with a small quantity of lead-tin yellow. Verdigris was usually mixed with an oil medium.

For comparison a sample of green pigment from the pedestal of the "Group with Apostle Peter" was investigated. In a microscope it was seen that the paint consisted of large crystals (100-150 μ) of turquoise colour. These crystals dissolved in HCl and HNO_3 without foaming. Copper was distinguished by means of micro-

chemical reactions. An attempt to identify this pigment on the basis of data obtained by X-ray diffraction analysis was not a success (Table 3). The paint's IR-spectrum (Fig. 1,f) was found to be similar to that of the green paint from Norwegian icons (5). The authors who investigated pigments of Norwegian icons came to the conclusion based on spectrum analysis that the icons' paint consisted of verdigris and an oil medium.

A comparative analysis of the spectra obtained shows that if the pigment of overpainting is verdigris it is different from the verdigris found in the original decoration.

Table 3. Debye-Scherrer patterns of the green paint sample

d, Å	Intensity	d, Å	Intensity
6.80	very high	2.28	medium
5.22	low	2.10	low
4.35	very low	2.02	medium
3.46	high	1.93	low
2.88	low	1.86	high
2.67	high	1.81	low
2.43	hight		

<u>The layer</u> covering the gilding on St Victor's shield. The IR-spectrum of this substance (Fig. 1,g) in many ways resembles some of the previons spectra (Fig. 1,c,d) making it possible to conclude that egg white is present in the covering layer. It was also confirmed by chromatography of the sample's hydrolyzate. The covering layer, however, also contains vegetable oil: the IR-spectrum of a compound extracted from the sample by chloroform was absolutely identical to that of a substance extracted from the paint layer of an eighteenth century oil painting (Fig. 1,h). It is difficult to

tell whether oil had been added initially while

covering the sculpture with egg white or it was brought in while renovating the altar figures.

Grounds. It was found by means of X-ray diffraction analysis and IR-spectroscopy investigations that calcite was the main component of the ground in all the sculptures. Gelatin was applied as a medium besides, traces of oil were discerned in the ground (8). As in the previous cases it is difficult to tell whether the ground had been saturated with oil initially or the oil penetrated into the ground during renovations.

Conclusions

The investigations undertaken helped to determine the composition of pigments and some other painting materials applied in the 15th century polychrome wood sculpture.

1. White pigment of the author's painting and overpainting is a mixture of basic carbonate lead white with a small amount of cerussite.

2. Blue pigment is azurite with an insignificant, possibly natural, admixture of malachite.

3. The main red pigment is cinnabar. The red paint consists of two-layers: a thick layer of cinnabar is overlaid with a thin glazed layer of carmine lake and, later, with egg white.

4. The main green pigment is verdigris. Painting with green colour performed was also by stages: First the ground was saturated with egg white and then covered with a layer of lead tin yellow, followed by a layer of verdigris with a small admixture of the same pigment.

5. The ground was made of $CaCO_3$ and gelatin.

6. Initially, the decoration was possibly covered with egg white for the latter was identified in the covering layer of gilt and red paint.

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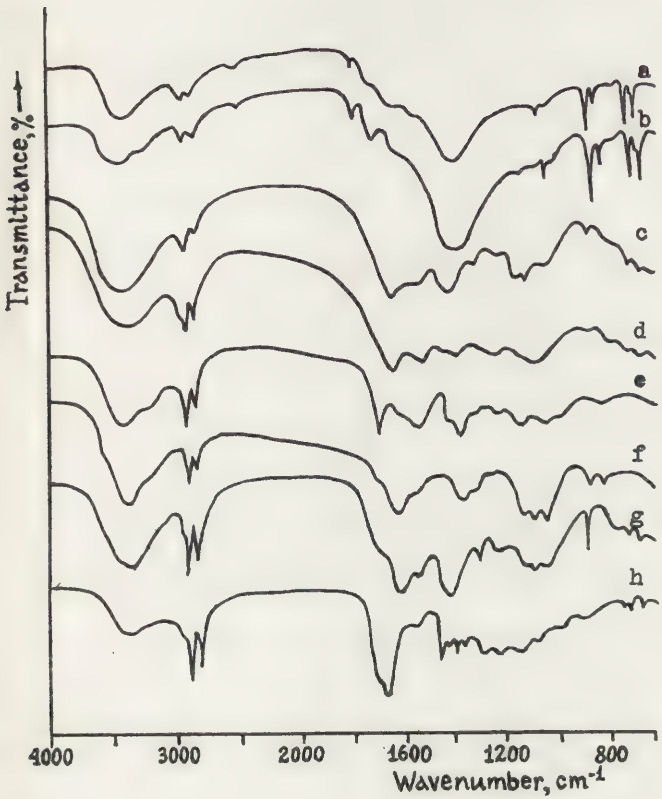

Fig. 1. IR-spectra of painting materials

COMPARISON OF GELATINS ISOLATED FROM GROUNDS OF POLYCHROME PAINTING OF WOOD SCULPTURES AND EASEL TEMPERA PAINTINGS OF THE 15TH-18TH CENTURIES

V.J. Birstein

Many methods applied in the 15th - 18th centuries to prepare grounds for easel paintings and polychrome sculptures have been mentioned in the literature (1,2). Various types of gelatins were used as the glue for this purpose: hide glue, bone glue or isinglass. It is believed that the binding medium of Russian icons' grounds was produced by boiling dried-up swimming bladders of the sturgeon (3). Depending on what kind of animal collagen was used to make the glue as well as on the method of its production the properties of the resulting solutions differed. It can be assumed that processes accompanying natural ageing of gelatins in grounds were also somewhat different. It is indirectly proved by the fact known to restorers, namely that the nature of decay in grounds of West-European paintings and polychromes, on the one hand, and of Russian icons, on the other hand, is different. To clarify the nature of the glues the present investigation endeavoured to compare amino acid composition of gelatins extracted from grounds of five 15th - 18th century West-Europesn sculpture paintings and five 15th - 16th century Russian icons.

Samples of grounds

I. Sculptures:

(1) A figure of St Elizabeth, 1483, from the altar made by craftsman Bert-Notke, Church of Holy Spirit, Tallinn (Esthonian SSR);

(2) A figure of St Victor from the same altar;

(3) A figure of St Anne from the same alter;

(4) A figure of St Olaf from the same alter.

Samples 1-3 were taken from flows of the ground on the back unpainted part of the sculptures while sample 4 was taken from the sculpture's base. Besides, a piece of pure glue found on the back of the sculpture was taken off the figure of St Victor.

(5) A figure of Christ in the group "The Crucifixion", 18th century, Lvov. The sample is taken off the fut of the sculpture.

II. Icons:

(1) "Archangel Michael", ~ 1497, the Assumption Cathedral, Kirillov;

(2) "Apostle Paul", ~ 1497, in the same place;

(3) "Trinity", ~ 1553, the Assumption Cathedral, Byelozersk;

(4) "Judah's Kiss", ~ 1553, in the same place;

(5) "Apostle Peter", ~ 1572, the Church of John Clymax, Kirillov.

All samples were taken off the icons' edges.

Results

Before extracting the binding media the samples of grounds were preliminary examined by means of IR-spectroscopy ("Perkin-Elmer 257"spectrophotometer, 4000-625 cm^{-1}, KBr-pellets). Chalk was found in the majority of samples (Fig. 1,b; bands at 3420, 2500, 1800, 1425, 875 and 710 cm^{-1}); the ground of "Judah's Kiss" consists of gypsum (Fig. 1, a; bands at 3540, 3400, 1685, 1620, 1140, 1115, 670 cm^{-1}); the ground of the "Trinity" is made of the mixture of two minerals.

For isolation of the binding media ground samples (50-100 mg) were dissolved in a 5% solution of trilon B;

the obtained solutions were dialyzed against water during 72 hours and dialyzate were evaporated. Investigations of the compounds by means of IR-spectroscopy proved that it was either pure gelatine (Fig. 1, c) or gelatine mixed with lipids (Fig. 1, d) - in the case of the compounds isolated from the ground of the altar sculptures. The lipids are likely to be residues of oil by which the grounds had been initially saturated or, more likely, which penetrated inside during renovations of the paintings.

Contents of gelatins found in 10 mg of grounds are given in Table 1. Gelatin contents in relation to the filler varies significantly, though it is not less than ~ 0.5 mg per 10 mg of ground. It is known that different amounts of gelatin can be found in different parts of the ground in one and the same picture (4).

Table 1. Gelatin amount per 10 mg of ground

Work of Art	Gelatin amount mg/ /10 mg
I. Sculptures:	
1. St Elizabeth, 15th c.	0.8
2. St Victor, 15th c.	0.9
3. St Anne, 15th c.	0.5
4. St Olaf, 15th c.	1.1
5. Crucifixion, 18th c.	0.8
II. Icons:	
1. Archangel Michael, 15th c.	0.6
2. Apostle Paul, 15th c.	0.5
3. Trinity, 16th c.	0.5
4. Judah's kiss, 16th c.	1.6
5. Apostle Peter, 16th c.	0.7

Amino acid compositions of isolated gelatins (Table 2, averages of two parallel determinations) were de-

termined by means of a "Hitachi KLA-3B" amino acid analyzer according to the double-column method of Moore and Stein. Gelatin samples (2 mg) were hydrolysed in 5.7 N HCl under vacuum for 24 hours at 110°C. Hydrolysates were evaporated in a rotating evaporator. Similar samples of sturgeon glue and leather fragments taken off a doll of the 1st - 2nd century A.D. found in Siberia during excavations were also hydrolysed as controls.

The data obtained make it possible to conclude that amino acid compositions of all the examined gelatins and the leather are similar, and no decision can be made as to what particular animal collagen had been used to prepare gelatins. This is not surprising since amino acid compositionsof collagens of different animals resemble each other (5). Reliable data on the differences in gelatin compositions are likely to be obtained only through multiple parallel assessments. To ascertain the type of gelatins other methods should be used, for example, electron microscopy (6).

The isolated gelatins did not dissolve either in water or in 0.1 M $NaHCO_3$ with 8 M urea; nor did they dissolve in 1 N KOH or 0.5 M acetic acid applied to solubilize collagens or after sodium dodecyl sulfate treatment (1% solution, 100°C, 5 min.). Only the pure glue taken off the figure of St Victor was easily dissolved in water.The change of this property is, apparently, due to dehydratation of gelatin molecules in grounds during the ageing process which is likely to be accompanied by polymerisation of the adjacent chains (7). It could be assumed that the decay usually observed in grounds of easel paintings and polychromes is partly connected with changeing solubility of gelatins.To solve the problem of the natural ageing of gelatins further efforts should be undertaken to in-

vestigate properties of extracted gelatins.

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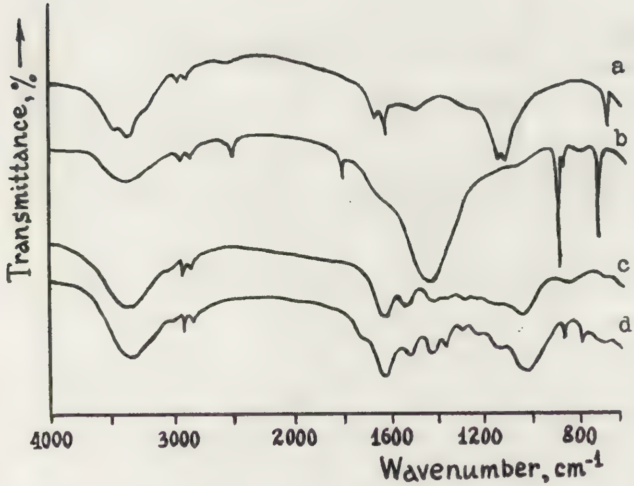


Fig. 1. IR-spectra of grounds (a,b) and extracted gelatins (c,d).

Table 2. Amino acid composition of gelatins extracted from the grounds (Mole %)

	St Elizabeth	St Victor ground	St Victor glue	St Anne	St Olaf	Crucifixion
Lysine	1,81	2,67	2,90	2,31	2,56	2,47
Histidine	+	0,69	0,53	0,37	0,48	0,41
Arginine	4,07	4,06	5,40	4,45	4,64	4,72
Hydroxyproline	5,99	6,85	6,06	4,92	5,73	6,30
Aspartic acid	5,37	8,04	5,12	5,08	5,68	5,47
Threonine	2,29	3,46	1,98	2,21	2,11	2,31
Serine	3,55	6,66	3,35	3,44	4,22	3,83
Glutamic acid	8,88	9,39	8,38	9,10	9,78	8,83
Proline	11,87	8,62	11,60	10,93	11,15	11,11
Glycine	35,82	30,13	35,26	36,26	30,33	33,52
Alanine	12,27	9,69	11,19	12,19	12,76	11,53
Valine	2,27	3,71	2,20	2,42	2,63	2,30
Methionine	0,73	0,75	0,72	0,59	0,69	0,51
Isoleucine	1,24	2,52	1,45	1,37	1,75	1,42
Leucine	2,60	4,60	2,39	2,79	3,97	2,86
Tyrosine	+	1,05	+	0,38	+	0,66
Phenylalanine	1,24	1,91	1,47	1,29	1,52	1,59

Table 2 (continuation)

Arch.Mi-chael	Ap.Paul	Trinity	Judah's kiss	Ap.Pe-ter	Sturge-on glue	Leather
3,11	1,86	2,29	2,65	1,85	2,16	2,12
+	+	0,34	+	+	0,56	0,49
3,32	4,61	4,87	6,23	4,50	5,38	4,45
4,75	5,97	6,36	5,12	6,96	5,16	8,22
6,11	5,72	7,10	5,12	5,99	4,99	4,66
2,40	2,55	2,93	2,04	2,45	2,85	1,97
5,69	3,88	4,63	3,64	3,93	4,98	3,74
9,75	9,48	8,39	8,42	9,93	7,83	7,38
8,20	11,29	10,03	10,56	12,16	9,31	11,57
34,88	32,34	32,52	36,79	37,06	35,53	35,18
11,53	13,60	11,13	11,02	6,64	13,03	10,31
2,44	2,47	2,98	2,37	2,54	2,02	2,72
0,35	0,59	0,81	0,60	0,61	1,47	0,88
1,34	1,68	2,18	1,30	1,42	1,42	1,30
2,65	2,98	1,92	2,67	2,69	1,76	2,90
+	0,62	+	+	+	+	0,78
1,41	1,41	1,52	1,47	1,26	1,55	1,53

PEINTURE DU XXe SIECLE

Coordinator : P. Cadorin (Switzerland)
Assistant coordinator: D. Giraudy (France)
Members : H. Althöfer (Fed. Rep. of Germ.)
G.A. Berger (USA)
S. Bjarnhof (Denmark)
S. Brans (France)
R.L. Feller (USA)
I.P. Gorine (USSR)
W. Hahn (Fed. Rep. of Germany)
R. Hammacher (Netherlands)
M. Havel (France)
H. Kühn (Fed. Rep. of Germany)
J. Leymarie (Italy)
F. Parra (France)
N. Stolow (Canada)

<u>Programme 1975-1978</u>

1. Le coordinateur proposera à Zagreb au Conseil de Direction les personnes suivantes comme membres du Groupe de travail.
Celles-ci ont déjà contribué activement aux travaux du groupe:

- Pinin Brambilla-Barcilòn
Restaurateur en chef
Laboratoire du Musée d'Art Moderne
Castello Sforzesco
Milan (Italie)

- Stella Matalòn
Anc. Conservateur
Pinacoteca di Brera
Associazione Amici di Brera e dei Musei Milanesi
Via Brera 28
I-20121 Milan (Italie)

Mesdames Brambilla-Barcilòn et Matalòn, anciennes collaboratrices de Franco Russoli, continuent son travail de recherche en Italie.

- Emil Bosshard
Restaurateur en chef
Institut Suisse pour l'Histoire de l'Art
Waldmannstrasze 6/8
8024 Zürich (Suisse)

Recherches dans le domaine de la peinture moderne suisse: Amiet, Hodler, A. Giacometti, Max Bill, etc.

- Eduardo Porta
Chef du Laboratoire

- Eduardo Porta
  Chef du Laboratoire
  Museo Arqueologico
  Parque Montjuic
  Barcelona 4 (Espagne)

  Recherches dans le domaine de la peinture espagnole:
  Mirò. Picasso, Dali, Tapiès, etc.

GROUPE DE TRAVAIL: "PEINTURE DU XXème SIECLE"

RAPPORT DU COORDONNATEUR

Coordonnateur: P. Cadorin
Kunstmuseum
St. Albangraben 16
CH-4010 Bâle
Suisse

Lorsqu'en septembre 1969 à Amsterdam le groupe de travail "Peinture du XXe siècle" annonça qu'une enquête systématique allait être entreprise auprès des artistes pour connaître les matériaux et les techniques qu'ils utilisent, des initiatives isolées avaient déjà été prises dans ce domaine. Entretemps, des informations sur ce sujet ont été réunies:

- en France par Danièle Giraudy
- en Allemagne par H. Althöfer et Gantzert
- au Canada par N.Stolow
- en Italie par Franco Russoli, puis par P. Brambilla-Barcilòn et S. Matalòn
- au Danemark par S. Bjarnhoff
- en Espagne par E. Porta

Ces diverses enquêtes ont été faites au moyen d'un questionnaire et de contacts directs avec l'artiste. La difficulté de ces recherches est due au fait que l'artiste parfois ne comprend pas les demandes qui lui sont faites par le questionnaire, ou ne se rappelle pas toujours avec précision quels matériaux il avait utilisés dans le passé. D'autrepart il est superflu de rappeler que souvent un artiste répugne à se soumettre à la rigueur statistique d'un questionnaire et qu'un contact direct est nécessaire pour obtenir des réponses relativement fiables.

Pour ces raisons, l'enquête durera encore un certain temps avant que les premiers résultats d'ensemble puissent être réunis. D'ailleurs, toutes les indications reçues des artistes devront être confrontées aux résultats de l'examen de leur oeuvre.

De plus le contact direct avec l'artiste nous révèle parfois des détails importants pour la connaissance de son oeuvre, grâce à des informations qui, la

plupart du temps, ne peuvent pas être prévues dans un questionnaire. Par exemple: Pablo Picasso nous apprend qu'il a intentionnellement intégré une coupure de journal contenant un fragment de discours de Jaurès dans un de ses papiers collés (P.Daix: La vie de peintre de Pablo Picasso. Seuil 1977).

Au cours du Symposium sur la restauration de l'art moderne organisé en 1977 à Düsseldorf par H. Althöfer, réunion à laquelle étaient conviés outre de nombreux spécialistes de la conservation de l'art contemporain, aussi des artistes, et ceci pour la première fois, nous avons eu l'occasion par exemple d'apprendre au cours d'une conversation avec le peintre allemand Konrad Klapheck, que celui-ci ne voulait absolument pas que ses toiles, en cas de relâchement, soient retendues selon la méthode usuelle qui est d'élargir le châssis à ses quatre angles au moyen de clés: Klapheck a insisté pour que ses toiles soient détachées et retendues tout autour du châssis.

Ayant été invités à participer à la réunion annuelle des restaurateurs allemands tenue en 1977 à Augsbourg, nous avons pu apprécier l'idée, nouvelle elle aussi, de faire participer à la réunion des agents d'assurances. Parmi les idées neuves issues de cette rencontre, citons qu'au cours des débats sur les risques de dégâts auxquels sont exposées les oeuvres d'art (particulièrement au cours de transports), il en est un qui n'est pas couvert par les assurances: le risque dû aux changements de climat. Un cas représentatif de ce danger sera exposé plus loin dans la communication "Examen de différentes causes de dommages auxquels sont exposées les oeuvres d'art contemporain". Les assureurs se sont montrés très intéressés par cette importante lacune et se sont empressés de garantir leur appui pour permettre de trouver une solution appropriée à ce problème.

Incontestablement, l'ampleur de l'entreprise visant à examiner, documenter et communiquer des informations sur l'art du XXe siècle est telle, et l'art contemporain est encore si proche de nous, que souvent, même le spécialiste se trouve désarmé devant la multiplicité des cas et devant leur complexité. Pour ces raisons il nous a paru vain et prématuré de vouloir déterminer le programme d'une recherche dont l'objet est immense et en perpétuel devenir. De plus, nous dépendons pour notre recherche de l'expérience que des spécialistes ont eu l'occasion d'acquérir. Nous préférons donc organiser nos recherches en demandant à ceux-ci de nous communiquer les cas spécifiques dans la conservation de l'art contemporain qu'ils ont eus à résoudre pour tenter en-

suite de regrouper ces témoignages en donnant la précédence aux problèmes les plus urgents.

Un de ces domaines est celui de la lacération de la toile: qu'elle soit accidentelle ou élément constitutif de l'oeuvre d'art, c'est à dire volontairement provoquée par l'artiste (ex.: Lucio Fontana). Le problème de la restauration d'une déchirure accidentelle, ou du maintien d'une lacération voulue dans sa forme originale fait l'objet aujourd'hui des recherches de plusieurs spécialistes. Dans les rapports qui vont suivre, on trouvera les premières indications sur ce thème. (Contributions de P. Brambilla-Barcilon, S. Bjarnhof).

Puisque prévoir les dommages est toujours la première mesure de conservation de l'oeuvre d'art, nous avons cherché à attirer l'attention sur quelques cas dont nous avons été témoin, où des mesures préventives avaient été insuffisantes (surtout lors de transports), parcequ'elles étaient inspirées de l'expérience des dégâts risquant d'endommager des oeuvres d'art traditionnel.

Les mesures de conservation préventive au sens d'une intervention dans la substance de l'oeuvre, mesures que préconise Gustav Berger dans sa contribution, sont dues à nos préoccupations toujours croissantes devant l'état de conservation précaire dans lequel se trouvent de nombreuses oeuvres d'art contemporain: les propositions de cette contribution méritent toute notre attention. Cependant, même en admettant que la méthode proposée n'entraîne pas le danger d'ajouter de nouveaux phénomènes de vieillissement à ceux déjà en développement dans l'oeuvre traitée, nous ne pouvons cacher nos réserves personnelles devant une généralisation de l'idée d'une restauration préventive des oeuvres d'art.

Un autre aspect de la conservation de l'art contemporain qui pose au spécialiste de graves problèmes est celui de la décoloration de certains pigments. Sur ce sujet, traité plus loin en deux communications (respectivement sur Max Bill et sur Delaunay), d'autres articles vont suivre ultérieurement.

Un facteur de grave incertitude pour le restaurateur est celui de la juste interprétation des interruptions dans la couche picturale: lacunes accidentelles ou surfaces non-peintes de la toile faisant partie intégrante de la vision de l'artiste.?

Tout récemment sont apparus deux aspects nouveaux de la conservation de l'art moderne. Le premier: les problèmes posés par la conservation et la restauration d'oeuvres exécutées dans des matièrés organiques extrêmement périssables (oeuvres de Dieter Roth, Daniel Spoerri, Beuys etc...). Le second: la conservation

d'oeuvres exposées à un public particulier: celui des non-voyants. Ceux-ci, apréhendant l'oeuvre d'art par la seule sensibilité de leurs mains, nous nous trouvons devant un phénomène particulier d'usure - prévisible en grande partie au moment du choix des oeuvres exposées. (usure de la patine des bronzes, usure particulière de certaines parties d'une sculpture, depôt de salissures et d'acides gras). Il va sans dire que le choix des oeuvres mises à la disposition de ce public a été fait en toute connaissance de cause. Néanmoins des mesures particulières de protection des objets exposés ont dû être prises (diverses formes de "coating"). Un restaurateur de Paris s'est déjà mis à disposition pour résoudre ces problèmes nouveaux.

*à ne pas confondre avec les "objets tactiles" par exemple d'Agam.

PREVENTIVE CONSERVATION OF PAINTED OBJECTS

Gustav A. Berger

Abstract: Unsatisfactory techniques and materials used in the construction of art objects make their rapid decay predictable. The owner of such art work is forced to accept the fact that he possesses an object which was not made to last.

The author suggests "preventive treatments" for painted objects which would prolong their life for many years to come. In his opinion it is the professional duty of the conservator to preserve these objects for the future in spite of the fact that some artists built their works to self-destruct.

Great advances have recently been made in understanding the causes of decay of paintings. In the light of these findings, the author lists new measures to prevent the decay of paintings.

A conservation report on a work by De Kooning, oil on newsprint, is given as an illustration.

Introduction

Many paintings, particularly those created by modern and contemporary artists, decay at an increasing rate due to faulty techniques and the use of unsatisfactory materials. These paintings, which are still often in private hands, suffer not only from the increased air pollution of our times but also from frequent transportation and the erroneous notion that 'nothing can happen to a painting if it is not touched'. It is important to counteract this tendency of leaving art to natural decay by stressing that many modern art objects could benefit from what may be termed "Preventive Conservation".

In the past few years a great deal has been learned about the aging behavior of the polymers which make up paints, glues, plastic materials and cellulose used in the construction of art objects, and this knowledge may be utilized to improve their preservation. In order to keep this paper within manageable limits, it was decided to devote it mainly to the preservation of painted objects. However, the mechanical behavior and the aging of paint is very similar to that of all organic high-polymer substances; This will permit the reader a comparison with similar substances such as wood, paper and plastics.

As long as paint is protected from outside influences, as when it is in the tube, its hardening is so slow that it practically does not

progress at all. As soon as it is painted on a substrate, the paint is exposed to light, oxygen and evaporation, and it begins to harden and cross-link. Shrinkage of the paint film usually proceeds quite rapidly in the first years of its exposure, and continues indefinitely although at a much slower pace (1). The shrinkage starts from the top layer where the paint film is directly exposed to the influences which cause it to contract. The shrinking top layer forms a tightly stretched film on top of the softer and still more pliable lower layers. Since every particle of this film is held by its substrate and by its surrounding particles, the paint film cannot contract laterally (horizontally) as long as it remains intact, i.e. maintains its mechanical integrity. As shrinkage proceeds deeper and deeper, the top layer comes under increasing tension. If the paint film were an elastic solid, rapid cracking would occur in every case. However, paint is subject to plastic deformation as a highly viscous liquid, and behaves somewhat like chewing gum which when pulled slowly enough will deform without tearing or cracking.

The principle of plastic deformation is of such importance for the understanding of the behavior and decay of the paint layers that a short discussion is necessary before consolidation measures can be described. Plasticity implies that a material is capable of being permanently deformed by flowing like a liquid in any direction without rupture, as long as the limits of its breaking stress are not exceeded. Without rupture means that the mechanical properties of the material are not damaged by the deformation: the material can be bent without losing its strength and elasticity, and often most of its appearance. For example, a wooden bow can be permanently bent without losing its texture or the shape of its cross-section. This is in contrast to the elastic behavior of "ideal solids". To qualify as an "ideal solid" with perfect elasticity, a substance would have to maintain its resistance indefinitely when subjected to a given stress and completely return to its original form when the stress is released. However, even the strongest steels ultimately yield to stress and betray the fluid property of elongation also called creep or plastic deformation (viscoelasticity) (2).

Plastic deformation can best be visualized by considering plastic materials as consisting of long chains of fibers and crystals in random arrangements, not unlike a plate of very long cooked spaghetti. This felt of long fibers is kept from moving internally by 'hooks' (entanglements), often called 'secondary linkages' (Fig.1). Both, the fibers and hooks are elastic and, as long as the strength of the secondary linkages is not exceeded, the plastic material behaves like a steel spring. It gives under stress and springs back all the way to its original position as soon as the stress is released (Fig.2). However, if the strength of the secondary linkages is exceeded, they lose their grip and slippage begins (Fig.3). The slipping hooks catch the next available fibers, and the original elasticity returns but the material has changed its form (Fig.4). It takes time for the linkages to move from one anchoring site to the other, and, if they are too far apart before they can lock again, the material is overstressed

ELASTIC DEFORMATION AND PLASTIC SLIPPAGE (SCHEMATICALLY)

Fig. 1 No Stress
Hooks (H) hold the chainlinks (black to black) without deformation.

REST

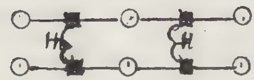


Fig. 2 Shear Stress
Shear stress causes upper chain to move one step to the left; Hooks still hold chainlinks, black to black, but are extended to the left.
Elastic deformation: one step.

ELASTIC DEFORMATION

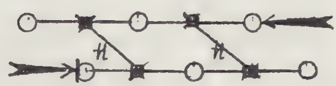


Fig. 3 Continued or Increased Stress.
Upper chain moves two steps to the left due to slippage of the hooks from white to black chain links. Hooks continue to be extended by elastic deformation one step to the left. Total deformation: two steps (Slippage and elastic deformation).

REATTACHMENT SLIPPAGE

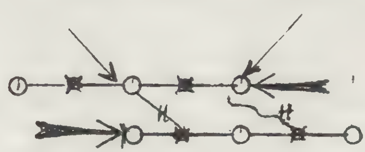
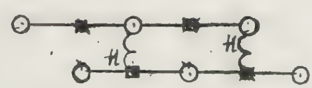


Fig. 4 End of Stress
The chain remains permanently deformed by one step because of the slippage of the hooks; Elastic recovery pulls the chain one step back.
Total deformation: one step.

PLASTIC DEFORMATION



Because of the entanglement between the chains elastic recovery sometimes takes time (elastic or plastic memory).

and breaks. One must realize that slippage encompasses both breakage and reattachment to another site. Thus, plasticity implies that a material can 'stick to itself', i.e. is so soft that its molecules can be brought close enough to each other to form secondary linkages. This happens to most materials when heated, just before they become completely liquid, and of course in the case of liquids which have a close resemblance to plastic materials. Consequently, this form of plasticity is called 'thermoplasticity'. All materials are susceptible to some degree of plastic deformation if given sufficient time, pressure and/or the right temperature. However, for all practical purposes, materials which decay before they approach their melting, or softening, point such as protein glues, concrete and many others, are not called thermoplastic. Thermoplasticity therefore implies a certain chemical stability of the material which enables it to reach the plastic stage when heated.

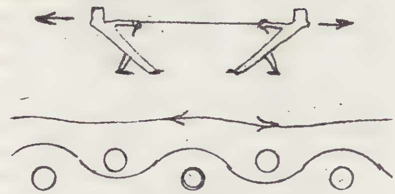
Another method of inducing plasticity into a polymer is to introduce solvents which swell the material. By interposing themselves between the fibrils and their secondary linkages the solvents act as a lubricant between the fibrils. This is the action of plasticizers. Plasticizers increase flexibility and plasticity but often also interpose themselves between crosslinks reducing their number and the number of secondary linkages. This causes a loss of tensile strength of the plasticized material.

Heat, solvent vapors and solvent osmosis are the most important tools of the conservator in the treatment of brittle art objects. These are used to soften old paint films and cellulose and make them plastic again.

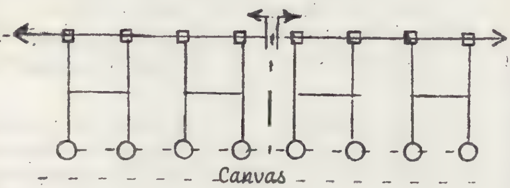
Paint films, especially when young, have plastic properties. These are progressively reduced by cross-linking which replaces the temporary secondary linkages by permanent chemical bonds which are not susceptible to slippage. This cross-linking creates three-dimensional structures which cannot slide internally. It transforms the paint film from a plastic felt of fibers to a stiff, brittle structure comparable to a cantilevered bridge. The compacting by cross-linking seems to be the prime cause of shrinkage. However, the plasticity of the paint film is never completely lost, and can always be increased by heat and solvents. The paint film remains permanently capable of absorbing at least some of the tensions created by its shrinkage (3).

The sound paint film before cracking grows thinner by plastic deformation so that actual shrinkage is confined to the vertical direction only (Fig. 5 and 6). However, from the above description it follows that plastic slippage is only a form of arrested breakage. The linkages between the chains do not break all at the same time, thereby making it possible for the molecules of the plastic material to attach themselves to other molecules nearby. The shrinking paint film during plastic deformation is already near its breaking point. Any additional load at this point can result in an overdose of little breaks leading

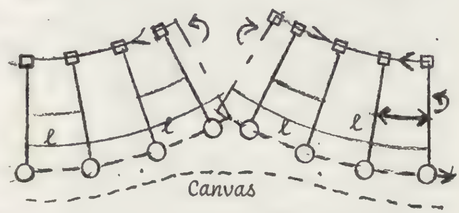
GEOMETRY OF A CUPPING PAINT FILM



5. The drying film shrinks and tightens like a string or a drum (self-flattening of paints and varnishes).

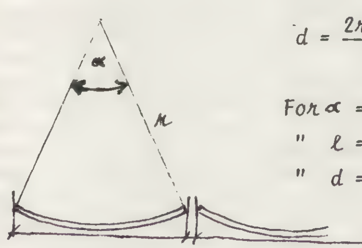


6. Shrinkage of the film can only lead to additional stretching and flattening as long as its surface is not broken.



7. When the film tears it is free to shrink horizontally. It puts the adjacent layer under compression, often causing the lower layers to expand. Sometimes this makes it impossible for the cupping to be bent down unless the canvas is enlarged by additional stretching. Alternately, there can also be a general shrinkage of the film leaving open gaps at the crack. Line 'l' shows where the cupped paint film is neither shrunk nor expanded.

8. Each cup of 60^0 curvature is by 5% narrower than the uncupped film. This is why there are two cracks of 5% extansion between each cupped paint island (e.g. in a 15mm paint island original flat size 15.7mm crack between islands is 0.7mm). This shortening is due entirely to its curvature, and not to the additional shrinkage of the paint film. The width of the crack might also be increased by plastic deformation (stretching of the canvas) when keying out the stretcher.



$\ell = r\sin\alpha$

$d = \frac{2r\pi\alpha}{360} - r\sin\alpha$

For $\alpha = 60^0$

" ℓ = 95% of to-

" d = 5% tal

In the film in Fig. 8, the maximum expected increase in length due to leverage by the shrinkage on top would be 0.5mm, - 0.2mm less than its loss in length due to cupping.

to a rapid decline of strength in the material followed by a complete break. Such an overload is often the result of temporary stress, and this is why cracks so often follow the form of temporary stress-lines within the painting as might be caused by movements of the substrate due to changes in humidity, vibrations or impact. Such shrot-term stresses acting on the already tightly stretched, shrinking, paint film are like the proverbial straw that breaks the camel's back. Because they tend to take on the form of obvious stress-lines they are often mistaken for the primary cause of cracking (4). By avoiding short-term stress, as is caused by vibration, transportation or through changes in temperature and humidity, one might prevent premature cracking, and instead permit the slow absorption of tensions by the plasticity of the paint film to proceed without interruption.

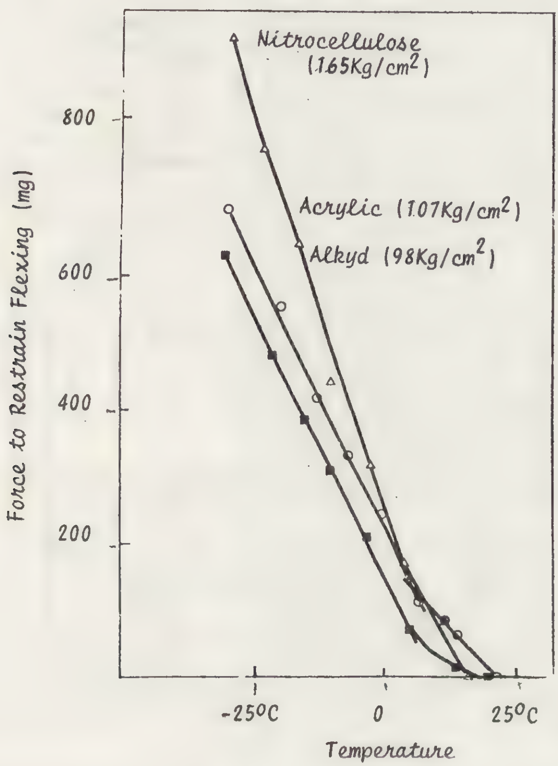
Once the paint film cracks, it shrinks more freely in the horizontal direction, since its movements are no longer inhibited by the resistance of the material on the opposite side of the crack (Fig.6 and 7). Because it is held in place by its adhesion, or sometimes cohesion, to the substrate which is still intact, a paint film does not shatter on cracking as does glass or an inflated toy balloon. However, shrinkage of the top layer is no longer laterally opposed at the line where it cracked: the top layer is now free to shorten by opening the crack wider. This puts the adjacent lower paint layers under compression; Sometimes it is capable of expanding the bottom layers of the paint and even the canvas (Fig.7). Thus, by leverage, we often find cupped parts of a painting bulging out from the back. Considerable shear forces are generated between the shrinking paint layer and the canvas which is stretched by the stretcher and subject to expansion and contraction by moisture and temperature changes. Plastic slippage can now begin between the top and bottom sides of the paint film or between the substrate and the paint layers. Again the same two alternatives exist: either the paint layers are still plastic enough to absorb, through slippage, the forces generated by the shrinkage of the upper layers and the movements of the substrate, or a new breakage must occur.

Before the initial cracks occurred, the opposing forces of shrinkage and cohesion were confined to a direction horizontal to the paint layer, pulling against each other (Fig. 5 and 6). When the break in the paint film occurs, the shrinkage at the edges is no longer confined, and a turning momentum is now generated by the shrinking top layer which pulls inward and the bottom layer which is pushed or pulled outward (Fig.7). This causes the edges to turn towards the direction of the shrinking top surface and generates forces vertical to the paint layer. If the substrate is soft it absorbs these forces, and the typical cupping of canvas paintings appears. If the substrate is rigid, such as a panel, a stiff canvas or even another layer of stiff paint, the forces of adhesion to the rigid substrate are either sufficient to allow the plastic slippage of the paint layer to continue, though solely in the horizontal plane, or they break. The cupping paint layer lifts off the substrate and cleavage between the substrate and the upper paint layer develops (Fig. 8). Such horizontal

Fig. 9

DROP IN INTERIOR TENSION OF PAINT FILMS WITH RISING TEMPERATURE
(Test by J.L. Prosser (3)

Internal Stress vs Temperature 35μ films



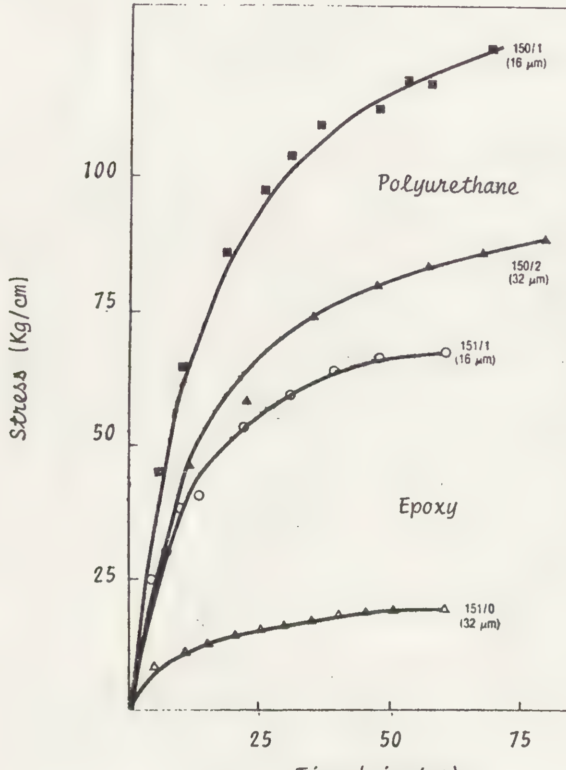
The softening effect of heat on paint films is long known to the conservator and utilized in the consolidation of paint films (ironing, using the hot table or heated spatula).

Fig. 10

INTERNAL STRESS INCREASES ON EXPOSURE TO DRY AIR (3)

(Test by J.L. Prosser)

Paint films equilibrated at 55% R.H. (18°C) were exposed at the start of the test to a flow of dry air of 15% R.H. (18°C).



Slightly unexpected is the enormous relaxing effect humidity seems to have on all organic polymers. The drying effect of wax impregnation and the usual application of the vacuum hot table goes counter to the relaxation of the paint film necessary for a successful consolidation. It could be considered one of the main advantages of glue-paste. One can only speculate on the softening effect of solvent vapors with more affinity to paint films than water.
The enormous forces generated by these films are also noticeable. The top value is 150 Kg/cm! This is 150 times the atmospheric pressure.

cleavage occurs not only between the support and the paint layers but can also be generated between different layers of paint and even within one, previously homogenous paint layer.

It is clear from the above description that the decay and distortion of paint films begins with cracking. A good proof for this statement is demonstrated by the old masters' paintings of the 15th, 16th and especially 17th century which have come to us in perfect condition without a single crack, or with only light secondary cracking. The perfect state of preservation of these paint films is due to the fact that their forces of cohesion and adhesion were always stronger than the forces generated by their shrinkage. In other words, their adhesive media were strong and flexible enough to be capable of absorbing, by plastic deformation, the stresses caused by shrinkage and movements of their supports. Since we cannot get modern artists to use the techniques and materials of the old masters, we must ask ourselves what we as conservators can do to impart modern paintings with properties which would prevent them from cracking and distorting.

There is another related cause of distortion most frequently found in modern paintings. It is a result of a simple mechanical fact: that a thick, hard paint has greater tensile resistance than a thin or weak paint. The shrinkage of a stronger paint will deform the weaker one, often before a crack occurs. Eventually, the weaker paint will crack first, and it is for this obvious reason that cracks often follow the brush strokes where there is such discontinuity of the paint film.

Still another problem is the weight of the heavy paint layer so dear to many modern and contemporary artists. Even before shrinkage begins, the weight itself leads to the deformation of the paint as well as to sagging and deformation of the plastic canvas which supports it. Intervention by the conservator is indicated in such cases. The more so, since the force which the future shrinkage of the heavy paint must create will be enormous. The force which distorts a paint layer comes from within, but in order to correct it, the conservator will have to exert equally enormous pressure from outside, while the paint film is still soft and vulnerable. Clearly, everything in our power should be done to prevent heavy paint from cracking and distorting (5).

When examining cracks we found that each shows a line where the paint layer, because of its inner tension, could no longer support stress and broke as a result. The total crackle patterns thus form a map of the greatest concentrations of stress on a painting. Since cracks have certain patterns common to most paintings, it might be helpful to study these maps of stress concentrations in an effort to find ways to prevent them. Here is what we have found so far:

1) Areas protected from light such as the edges of the painting covered by the rabbet of the frame, are usually free of cracks. Low light values seem to prevent decay and cracking of paint films since low light causes less shrinkage. This gives the paint film more time to absorb the stress by plastic deformation,

2) Areas protected by the stretcher from movements and moisture have lesser concentrations of cracks than do the exposed, unprotected areas between the stretcher bars. The paint in the protected areas is not overstressed by sudden movements. It can absorb the tensions generated by the paint film through plastic deformation. The worst cracks and concentrations of cracks usually follow the outline of the stretcher where a great diversity of movements occurs. It follows that protection from movement and changes in temperature and humidity should prevent cracking and decay of the paint film. Complete protection of the reverse of a painting, both from moisture and temperature differentials, and from hitting the stretcher bars during handling and transportation, would go a long way in preventing cracking (Fig.9, and Fig. 10),

3) Air pollution is one of the most frequent causes of decay of the paintings because it attacks the cellulosic supports. Advances have been made in the past few years in the technology of reinforcing cellulosic supports through impregnation with high polymers (6) and deacidification (7) which might enormously prolong the life span of paintings,

4) Paintings which have been well lined in the past have little or no new deformations. It seems that a timely reduction of deformations combined with firm adhesion to a stronger, more rigid substrate would impart some of the advantages of the technique of old masters even to weaker paintings,

5) Paintings on weak supports, or those made with heavy, uneven paint layers, would be greatly helped if mounted in time on a firm substrate with a strong adhesive capable of resisting the considerable tensions generated by hard and heavy paint.

Preventive Consolidation

The beneficiary effect that careful lining and consolidation have had on so many paintings in the past points to one way for their preservation. Conservators have been able to straighten deformed paint films and reattach them perfectly, and hopefully permanently, in their original position in the painting. By this action alone the effects of aging were counteracted because a straightened and reattached paint film is to a great extent relieved of the effects and tensions of its past shrinkage. Experiments by M. Watherston (8) and in our own laboratory have shown that it is possible to plasticize most paint films sufficiently to eliminate their deformation.

For modern paintings which so often utilize textural effects or fine tonal differences, cracking is an insufferable disfigurement. Suffice it to think of Ad Reinhardt's 'Black on Black' paintings which, when cracked, become almost unreadable. Therefore, let us attempt to plasticize such paintings before they crack. Let us try to firmly support their paint films before they are creased or deformed. The idea of

revitalizing and feeding the paint film is an old one. It is in a way realized by vapor treatment (8) and probably also by the author's use of polyethylene glycol on cracked paint films (5). N. Stolow proposed research for such a material in his studies of solvent action on aged paint films (9). Our own research on the effects of impregnation showed that wax might also have such an effect (10). R. Buck suggested that ways be found to modify the inherent properties of the paint and its support by non-destructive treatment (11). S. Keck feels that modification of the paint, though more unlikely, might yield useful results (4). Indeed, such modification is performed daily in conservation laboratories when consolidating paint. However, it seems to us that modern chemistry should be able to find a material which would reduce cross-linking in paint films. Such a material would soften the paint film sufficiently to allow for a continuos release of tensions and a permanent prevention of cracking.

Hazard-free mini-environments for our valuable paintings could be designed, which will not induce cracking and decay, and the design should be made known to all those responsible for the upkeep of collections.

In addition, the life span of paintings could be prolonged by better protecting their paint films from vibration and impact. The life of the support could also be increased by protecting it from air pollution and acid decay. Other ideas will come to us once we begin to consider a work of art as an object attempting to adjust to the effects of aging, and which should be helped along its way.

Conclusions

Recent practice and experiments have shown that cracking and cupping can be prevented if the paint film is kept sufficiently relaxed to adjust to tensions by plastic deformation. The following preventive measures might protect even marginally safe paintings from premature decay:

1) Paintings are not to be exposed to strong light,
2) Paintings are to be kept in controlled environments where the temperature and humidity are as stable as possible,
3) As much as possible, paintings are to be protected from vibrations and impact,
4) Chemical means (plastification) should be considered for preventing and/or counteracting cracking,
5) The use of plastification, vapor treatment and reformation as soon as cracking and cupping appear can stop their further development,
6) Lining of certain paintings on more rigid supports with strong adhesives can prevent future deformation and delamination of these particular paintings by forcing them to shrink without deformation,
7) Protection of the canvas support from air pollution, its deacidification and provision of an alkaline reserve can also be considered part of preventive consolidation.

78/6/1/12

De Kooning, Abstract Expressionist Painting, oil on printed newspaper, 23 x 29" (58 x 73.5cm), signed: De Kooning '74.

Condition:-

The paint is in some places at least 2mm high while other areas are completely devoid of paint and show the printed newspaper(12). The newspaper could not support the weight of the paint, and the painting could not be exhibited. The life expectancy of printed newspapers, even when not soaked with oil, is about 10-15 years which would make for a very rapid devaluation of a highly valued object.

Treatment:

Preventive deacidification to build up an alkaline reserve was carried out with Wei T'O Solution (7). The paper and brush were preheated on the hot table until all the water was driven out. Wei T'O was applied liberally with the predried brush to the hot paper.

The hot table was covered with silicone coated Kraft paper, and the painting impregnated with Bisra, an experimental solution of a stable, elastic high polymer, developed by the author for the internal strengthening of fibrous materials (6). Bisra was formulated to become opaque and white upon drying in order not to change the appearance of the paper. Its purpose was to reduce the effects of air pollution on the cellulose fiber and also because the life expectancy of the polymer exceeds that of the newspaper by several times.

The back of the newspaper was coated with a mixture of Bisra, calcium carbonate and titanium white to increase its reflectancy.

The painting was then mounted on fine fiberglass (Burlington style 116) with Beva 371. After mounting, the fiberglass was carefully trimmed off along the edges of the newspaper. The laminate was attached with Beva hinges to a sheet of plexiglass in order to keep the informal look of a loose newspaper.

A fine spray with a mat acrylic varnish (Acryloid B-67, Rohm & Haas) and microcrystalline wax makes it possible to clean the painting with water and aliphatic petroleum solvents.

An alternate treatment may be suggested: preventive deacidification and loose mounting on acid-free cardboard. This to be followed by complete encapsulation in a sealed plexiglass box.

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DISCOLORATION OF SYNTHETIC ULTRAMARINE
A CASE HISTORY

E.D. Bosshard

Abstract: The occurrence of discoloration of natural ultramarine called "ultramarine sickness" on traditional paintings is generally known.Although it has never been fully investigated, ultramarine sickness is usually explained as the result of exposure to acid in one way or another.
More recently discoloration of synthetic ultramarine has been noted on a number of paintings by contemporary Swiss artists.In the case described in this article, a loss of binding medium was found as a possible cause for this change in color. Infusion with additional binding medium is being attempted as a remedy.

Description of the Problem: The problem of "ultramarine sickness,"or the discoloration of natural or synthetic ultramarine blue on traditional paintings has been long known.No convincing explanation however, has yet been found for this phenomenon.

Although the preparation of synthetic ultramarine (Na-Al silicates that contain S) has been known since c. I828, the cause of the pigment's blue coloration was still unknown in the 2oth century (I) and was again a subject of study in I969 (2).

Just so has ultramarine sickness been long recognized,but its causes scarcely understood. Franz Kogelmann (3) observed and investigated as early as I892 a "Rot-Schein" (red-bloom) of synthetic ultramarine (in composition and structure identical with natural ultramarine) and attributed this appearance to the difference between the indices of refraction of ultramarine and its medium.Martin de Wild experimented with natural ultramarine bound in linseed oil (4) and bleached it by exposing it to sulfur dioxide and moisture.He believed that this color change was not reversible.Kurt Wehlte wrote in I96I (5) that most commercially available types of ultramarine have a tendency to effloresce and are sensitive to acids.

Joyce Plesters (6) wrote that on long exposure to even very dilute acids, natural ultramarine will decolorize and decompose. In her experiments she found that samples of natural ultramarine were decolorized by dilute mineral acids more slowly than samples of synthetic ultramarine. She also found that the symptoms referred to by the term "ultramarine sickness" can not be attributed to any single cause.

Both Hermann Kühn[7] and Martin de Wild[4] suppose that the pigment may be damaged by acids from air pollutants as well as from painting supports, under-paintings and paint medias.

For some years now increasing numbers of modern paintings executed with synthetic ultramarine have been evincing discolorations which are to be discussed in this article.The condition has been noticed on several paintings of the "Zurich School of Concrete Art", such as works of Max Bill, Richard Paul Lohse and Jakob Bill. All of these paintings were executed in the seventies,in the color field manner, where a discoloration is easy to discern.

A Representative Case: In order to simplify the investigation, a representative case was chosen. The painting "Condensation Towards Yellow" was painted in 1972 by Max Bill. It measures 150 x 150 cm and is based principally on hard-edged geometrical elements executed as uniform flat color areas. The two largest color elements are carried out in a very dark ultramarineviolet which today shows large bright areas of a cloudy efflorescence which became increasingly pronounced with the passage of time.Through the center of the picture run narrow bands of red, blue, yellow and mixtures of these primary colors. None of these colors show the discolorations seen in the violet.

The technique of this painting can be reconstructed as follows: The support is a commercial pre-primed canvas from the German firm A.Schutzmann type "Viktoria" DHK 5. The priming is a so-called "half-oil ground". "Rembrandt" oil colors from the firm Talens were used.These colors were applied to the ground directly without an isolating layer. The ultramarine violet in question (No.222, today No.507) was applied directly from the tube without any mixing or additives with a very broad spatula.Despite the uniformity of the color fields, the paint layer varies in thickness.As a surface coating a thin coat of"Lukas matt Varnish" was applied.

Results of the Examination: In order to find out the composition of the painting materials, the manufacturers were consulted and analyses of the priming and the color were carried out.

The priming contained as fillers and coloring agents barium sulfate,calcium sulfate,calcium carbonate,zinc sulfide and titanium white.As binding medium both protein (glue) and oil were detected.

A sample from the paint was analysed, as was the original paint tube provided by the artist. The result of these analyses indicated that "Rembrandt" Ultramarine Violet No. 222 from Talens consists of a mixture of ultramarine violet and ultramarine blue with a slight admixture of zinc white.Besides traces of copper, iron,lead,manganese and tin were detected,but the pigmen was very well washed and contained a minimum of salts.

The medium is purified linseed oil with a slight addition of lead manganate siccative.

Microscopic examination revealed that the discoloration existed not only at the surface of the paint layer but throughout its thickness as well. The discoloration was however noticably more severe where the paint layer was thinner than where thicker. In fact the thickest areas of the paintlayer still showed its original dark hue,but the same loss of color is visible beneath the surface in cross-section.

Reasons for the Discoloration: The history of this painting is so well known, that it is possible to rule out out the influence of excessive amounts of light and humidity at the outset.Knowing the composition of the priming,it is also possible to eliminate with certainty the possibility of a chemical reaction ofthis layer with the paint layer.Since it is known that some types of ultamarine are acid-sensitive,it would seem likely that the color here was bleached as a result of exposure to acid.As a possible source of acid the linseed oil medium was suspected.However it seems that, if that were the case,the paint should have changed more where the layer is thickest and richer in medium.As can be seen in the cross-section,there is more medium on the top of the thick ,unaffected paint areas than in the discolored ones.Therefore it must be concluded that this disfiguration involves the migration of medium into the absorbent priming whereby the optical properties of the color change.

Treatment Possibilities: It was attempted to replace the lost medium. In order to accomplish this the varnish coating had to be removed.Since the original colors were bound with linseed oil, attempts were made to introduce more linseed oil into the paintlayer. To this end the oil was thinned with appropriate solvents such as iso-octan.At first no improvement was seen,since the new medium was poorly absorbed by the paint's dried structure. Through partially softening (or swelling) of the paint with cellosolve,diacetone alcohol or methylene chloride the original coloration could be temporarily reproduced. This success lasted however only until the solvent evaporated.The admixture of Keton-N resin slowed the return of the bleached appearance, but resulted in no lasting improvment. The best results until today have been achieved through the application of a mixture of linseed oil, iso-octane and cellosolve.Further attempts are being made.

Analyses:Dr.B.Mühlethaler
Dr. H.Kühn
Translation:W.Newman

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TECHNIQUES EMPLOYEES PAR LE PEINTRE LUCIO FONTANA ET PROBLEMES DE CONSERVATION CONCERNANT SON OEUVRE

Pinin Brambilla-Barcilon et Stella Matalon

RESUME

Elargissant le problème soulevé lors d'une brève communication faite à Venise lors de la IVème réunion du Comité pour la Conservation en 1975 sur un aspect de la technique du peintre Lucio Fontana - celle des "buchi" (trous)-, l'article qui suit étudie un autre domaine de sa technique, à savoir celui des "tagli" (coupures). Un ensemble de problèmes de conservation se pose à cause des différences de tensions auxquelles sont soumises les toiles. Une recherche très approfondie et des essais ont dû être entrepris avant d'envisager des interventions sur l'oeuvre d'art elle-même.

La recherche s'est penchée sur la compilation d'une tabelle analytique sur laquelle ont été portées les données suivantes:

a) le type de supports (métaux, papier, toile, plâtre, etc.)

b) le type de couleurs (acquarelle, aniline, pastel, plâtre, huile, tempera, vernis à l'eau)

c) le type de matériaux appartenant aux techniques mixtes (sable naturel de grain plus ou moins fin, lumineux ou coloré, grains d'or ou d'argent, verres, etc.)

d) le type de fixatifs

e) le recensement des fabriques qui fournissent les matériaux; liste indispensable pour un programme de travail plus élargi.

Sur la base de cette enquête, nous présenterons pour chaque forme expressive de Fontana l'oeuvre la plus représentative pour l'emploi de ces matériaux, en étudiant son comportement au cours du veillissement et en tirant des considérations sur la conservation.

Le sujet de ce rapport (après les observations sur les trous) traite cette fois des coupures, ébauche d'une enquête qui sera poursuivie.

I <u>STATISTIQUE CHRONOLOGIQUE</u>

(ayant rapport avec les différentes méthodes employées par le peintre)

1957-1959 : expériences sur des supports de papier toilé blanc

1958-1959 : emploi d'aniline (environ 28 oeuvres)

1959 : emploi de pastel (21)

1959-1968 : emploi de toile grasse (16)

1959-1966 : emploi d'huiles (47)

1959-1968 : emploi de vernis à l'eau (900)

II CARACTERISTIQUES TECHNIQUES

a) Châssis : bois de peuplier fixé avec des clés angulaires

b) Supports : 1) papier épais et lisse, marouflé de toile calicot fine; presque toujours collé et fixé avec des clous sur le périmètre du châssis. Liant à base d'amidon.

2) toile naturelle et toile peinte avec de l'aniline et au pastel: sa trame est très fine, mince et compacte, avec une préparation de type commercial appliquée non pas sur la face mais l'envers du tableau.

3) toile peinte à l'huile ou au vernis à l'eau à trame d'épaisseur variable; toujours avec une préparation sur l'envers.

La coupure est exécutée quand la couleur n'est pas toujours sèche, mais à un stade déterminé d'humidité du support.

Nous avons des raisons de penser que la préparation sur l'envers de la toile est intentionnelle.

Dans quelques cas le peintre avait recours, après avoir effectué la coupure, à des pratiques particulières (application de fixations sur l'envers, ou renforts en toile) afin d'obtenir un résultat déterminant pour la forme des bords.

III CONSERVATION

a) Altération mécanique.

1) Evolution mécanique de la forme des coupures: vérifiée avec une étude photogrammétrique, s'étendant sur trois ans, comparant des différents types d'oeuvres placées dans des conditions diverses.

b) Altérations physico-chimique

Altérations de la couche picturale (pour citer un cas) dues à la différence de comportements dans le vieillissement des liants présents dans divers types de couleurs, utilisés sur le même tableau (liant de la couleur à l'huile, liant de la couleur vinylique à l'eau) : le phénomène est plus évident dans les tableaux monochromes et altérés au cours du temps. D'autres agents peuvent altérer les couleurs: action de la lumière, "smog", humidité, etc.

IV CONSIDERATION SUR LA RESTAURATION

Le problème le plus inquiétant est celui du rentoilage. Jusqu'à maintenant les systèmes de rentoilage sont demeurés traditionnels: ils présentent l'inconvénient d'altérer l'aspect original de l'oeuvre en nivelant les bords des coupures. C'est pourquoi nous nous sommes orientés vers une étude préliminaire en matière de prévention pour les dommages naturels:

a) une enquête avec une méthode d'interférométrie holographique pour localiser la distribution des déformations et des tensions présentes sur la toile à proximité des coupures et pour prévoir les points de rupture dans la structure.

b) Etude sur un modèle mécanique:

- construction d'un modèle semblable à l'original pour étudier son comportement.
- Vérification sur les toiles originales dans le but*déterminer les paramètres qui déclenchent la détérioration.

c) Conservation de la forme originale de la coupure et des formes de ses bords. Une des solutions tentées est celle de créer une contre-forme de l'oeuvre originale comme plan d'appui pour le rentoilage exécuté avec divers types de matériaux.

En conclusion de cette énumération de questions posées par la restauration de la peinture de Fontana, nous répétons que les problèmes soulevés constituent le programme d'une étude dans laquelle nous donnerons peu à peu des propositions et des résultats.

2) Accidents:

on observe quelques accidents particuliers qui rendent spécialement problématique la conservation des supports textiles en matière de coupures.
Un de ceux-ci est dû à l'interruption de la distribution naturelle des tensions sur la toile. Il se crée ainsi des concentrations de force telles, que celles-ci provoquent des lacérations évidentes aux extrémités des lèvres de la coupure.
Le nivellement et le relâchement des tensions ont probablement eu lieu après peu d'années de vieillissement.
La dégradation est due à la concomitance des faits suivants:

- cycles de tension-relâchement dont la toile est sujette à cause des variations de l'humidité ambiante. (Toutes opérations de nouvelles remises en tension de la toile pour éliminer les déformations causées par les vicissitudes climatiques ne font que reconstituer les prémices d'une déformation similaire, mais aggravée.)

- dégradation du matériau (constitué de fibre cellulosique ,de chanvre, de coton). Dégradation due à la diminution naturelle de la longueur des chaînes moléculaires avec une régression des caractéristiques mécaniques de la toile qui atteint progressivement un degré de fragilité.

D'autres inconvénients se présentent dans les cas où la toile est fixée le long des bords et sur le périmètre intérieur du châssis. Dans ce cas, toutes les forces subies par la toile se déchargent sur la ligne de contact du support avec le châssis et non sur les bords extérieurs, comme d'habitude: il en résulte une ligne de "discontinuité" sur la surface avec par conséquent des ondulations, des boursouflures, des ruptures ou des lacérations latentes, notamment le long du périmètre de la corniche. Toute action de tendre la toile sur son châssis devient problématique, voire impossible.

Lucio Fontana: "Dipinto argento" (Détail)

Exemple de déformation due à l'encollage
de la toile sur le chassis.

Lucio Fontana: "Concetto spaziale 150". Détail.
Exemple de coupure déchirée.

APERÇU DES DANGERS SPECIFIQUES AUXQUELS SONT SUJETTES LES OEUVRES D'ART CONTEMPORAIN

P. Cadorin

Le fait que les oeuvres d'art contemporain posent un problème particulier aux restaurateurs est bien connu aujourd'hui. La qualité des matériaux et la technique avec laquelle ils sont utilisés, de même que la nouveauté de la conception de l'oeuvre d'art en sont directement responsables.

Mais très souvent, une oeuvre d'art contemporain est endommagée par des accidents graves, voire irréparables, parce qu'elle est manipulée d'une manière erronée. Les facteurs de danger nouveaux et particuliers auxquels est exposé ce genre d'oeuvre ne peuvent plus être écartés uniquement avec les mesures de prudence préconisées pour les oeuvres d'art traditionel.

Ne considérant pas ici les problèmes de conservation inhérents aux matériaux utilisés par les artistes, (1), nous voudrions retenir l'attention des personnes responsables sur les risques d'accidents, afin d'éviter des dégâts qui peuvent revêtir des aspects catastrophiques.

Sur les oeuvres d'art traditionnel et sur les oeuvres d'art contemportain, les mêmes accidents ne correspondent pas nécessairement à des dégâts de la meme gravité. Il peut arriver qu'une tache, une égratignure jugées normalement comme un dégât secondaire, signifient en revanche un accident irréparable capable de dénaturer totalement une oeuvre d'art contemporain. En particulier, les peintures monochromes dans lesquelles la pureté absolue de la couleur joue un rôle déterminant, peuvent se trouver gravement endommagées par une seule marque de doigts. D'autant plus que ces peintures sont souvent exécutées dans une technique mate qui les rend encore

plus vulnérables à cause de la porosité de leur surfa-
ce; sans nommer le dommage que peut causer une seule
égratignure dans la surface absolument lisse et polie
d'une oeuvre dont la perfection de l'exécution consti-
tue un élément esthétique de première importance.

Le cadre peint par l'artiste ou l'absence de cadre qui
A fait que l'on ne peut plus manipuler l'oeuvre d'art
sans entrer en contact avec sa substance même est une
source continuelle de dangers. Même si l'effacement de
traces de saleté peut être une opération banale, il ar-
rive aussi que certaines souillures soient d'une téna-
cité inattendue et que leur élimination comporte des
B risques graves pour l'oeuvre elle-même.

Les grands formats, tout spécialement à cause de leur
dimension et souvent à cause de leur poids, présentent
des problèmes particuliers, surtout s'ils sont conjugés
avec les caractères déjà nommés, telles que la monochro-
mie et la matité. (Yves Klein, Stella, Newmann, etc.)

Si des dégâts graves comme une déchirure dans une toile
monochrome (voir la contribution de S.Bjarnhof) posent
des problèmes évidents de restauration, il est des dé-
gâts superficiels comme le crachat d'un visiteur offus-
qué ou le graffiti mal-intentionné, qui peuvent revêtir
des aspects d'une gravité insoupçonnée. Nous avons eu
l'occasion de vérifier ce fait au Kunstmuseum de Bâle,
où la couche de vernis d'une tableau de Barnett Newmann*
C a été profondément dénaturée par la salive d'un crachat.
La conséquence de cet acte de vandalisme fut la néces-
sité d'enlever totalement le vernis de l'oeuvre et de
le remplacer. Cette oeuvre semble le point de mire des
visiteurs non préparés: quelques années après, elle
fut l'objet d'un autre attentat. Des giclures d'une ma-
D tière inconnue, moussante et blanchâtre lui furent ad-
ministrées! qui purent être éliminées après un examen
de laboratoire approfondi.

La protection des oeuvres d'art contemporain dans les
musées est souvent confiée à la seule protection du per-
sonnel de garde, car les dimensions de celles-ci ou leur
facture nous empêche de les mettre sous verre. Dans la
mesure où les dimensions de l'oeuvre le permettent, cette
forme de protection est souvent la plus efficace, sur-
tout dans les cas de peintures portant de forts empâte-
ments qui alors ne seront pas seulement à l'abri de la
poussière et de la pollution atmosphérique, mais qui ri-
squent moins de se voir "allégés" de leurs empâtements
les plus saillants, étant inacessibles aux attouchements
des visiteurs.

* "The day before one"; 1951, 335 x 127,5

On peut trouver aujourd'hui dans le commerce des verres anti-reflet d'une telle qualité que leur présence est parfois difficile à détecter sur un tableau.(2) Ce moyen efficace de protection de l'oeuvre d'art est limité par la surface des plaques de verre spécial qui ne peut dépasser certaines dimensions. Le recours à d'autres matériaux transparents de protection est toujours possible, mais la présence de facteurs négatifs (coloration due à l'épaisseur, poids, reflets) est ressentie comme une trop grave entrave à la perception de l'oeuvre.

Il arrive que de nouvelles tendances dans la conception de l'oeuvre d'art comme l'invitation faite par l'artiste
- à entrer en contact physique avec l'oeuvre en la touchant,
- à participer à la création de l'oeuvre en ajoutant des éléments (comme dans certains "Happenings")

incitent certaines personnes du public à se manifester également, et de bonne foi, sur d'autres oeuvres. Ces dégâts, même s'ils ont une origine diamétralement opposée, sont en fin de compte équivalents à ceux provoqués F par le vandalisme: au Musée de Bâle, deux jeunes visiteurs se sont littéralement "inscrits" au stylo-bille sur un grand tableau de Twombly. L'élimination de tels graffitis noirs et profondément imprimés sur une surface presque monochrome, claire et mate a dû s'opérer mécaniquement (les solvants pénétrant beaucoup trop rapidement dans la couche de peinture absorbante, entraînant avec eux l'encre dissoute). Le contrôle constant sous la loupe binoculaire était indispensable pour ce travail, compliqué par le fait que la pression du stylo-bille avait creusé une dépression en forme de caniveau dans la matière picturale tendre du tableau, et qu'il fallait éviter à tout prix de léser la couche picturale superficielle sous laquelle apparaissait au moindre accident une couche de préparation presque noire, - ce qui aurait provoqué d'autres dégâts pires que le premier. Dans ce cas la restauration de l'oeuvre était compliquée par la nécessité de retoucher une surface monochrome et mate, dans laquelle le ton de la couleur originale est la résultante de facteurs complexes dépendant des pigments, du liant utilisés, comme de la technique mise en oeuvre par l'artiste.

Dans le même ordre d'intervention, les cas particulièrement difficiles à maîtriser sont ceux où le ton n'est pas constitué par des pigments colorés, mais par des matières inertes comme la craie, le plâtre en différentes concentrations dans le liant, et appliqués avec des procédés propres à l'artiste.

Sans vouloir dresser ici une liste des dangers qu'encourt une oeuvre d'art contemporain, (liste qui

devra être établie un jour pour un manuel destiné à l'usage de ceux qui sont concernés par de tels objets) nous ne voudrions pas omettre de signaler certains dangers typiques que court l'oeuvre d'art contemporain lors d'un déplacement.

Même si tous les problèmes concernant le transport des oeuvres d'art sont traités au sein d'un groupe de travail à part, il n'est peut-être pas inutile de rappeler ici qu'une grande part des dégâts surviennent aux oeuvres d'art contemporain au cours d'un transport. Et non seulement au cours d'un voyage extérieur au bâtiment qui les abrite, car la manipulation des oeuvres à l'intérieur des salles d'exposition est déjà source de dangers de toute sorte.

Pour les oeuvres en déplacement, bien à l'abri dans leur caisse, d'autres dangers sont aux aguêts:

- La pluie imprévue et brève qui mouille à peine la caisse qu'on vient de décharger à l'aéroport. Accident sans gravité? - Un tableau de Noland a subi un dégât total dû à un tache de moisissure indélébile (3).
- Les vibrations provoquées par les ultrasons des réacteurs d'avions qui peuvent entraîner des dégâts mécaniques (4). Monsieur Henry Cohen, restaurateur des sculptures au Museum of Modern Art de New-York, nous a communiqué que des fissures étaient apparues dans un bronze d'Alberto Giacometti qui avait été transporté en avion de Tokyo à New-York. Lui aussi attribuait ces fissures aux ultrasons provoqués par les réacteurs.
- Les brusques changements de climat qui ont provoqué des efflorescences sur la couche picturale d'un tableau de Delaunay (5).

G

- Le drap ou pis encore, la couverture qui, au lieu de protéger une oeuvre non-emballée dans une caisse, risque d'arracher des pastosités de la couche picturale.

E

- La feuille de plastique étanche qui protège parfaitement la surface peinte d'une toile ultra-sensible d'Olitsky (goutelettes de peinture acrylique claire, appliquées au vaporisateur sur une toile brute); on croit le tableau bien protégé, mais des giclures d'un liquide sombre ont pu l'atteindre par l'arrière et causer un dégât important.

H

- L'excès de zèle ou l'ignorance d'un douanier qui pose son tampon encreur sur la surface d'une oeuvre d'art car il n'avait pas reconnu celle-ci comme telle. On

connaissait les cas de tampons de toutes sortes apposés sur les dessins ou sur l'arrière des toiles qui étaient parfois attaquées par l'encre du timbre. Dans le cas nommé ici, il s'agit d'un relief peint par Hans
K Arp qui a été endommagé par le sceau d'une douane.

Dans le cours de la dernière décennie, l'effort fait par les musées pour permettre à un plus vaste public d'entrer en contact avec le patrimoine artistique et culturel, a été couronné d'un succès indéniable. Les expositions temporaires d'oeuvres appartenant au musée -sans être toujours exposées au public pour différentes raisons- , les expositions thématiques, scientifiques ou de collaboration internationale ont touché un si large public que cette activité muséale ne peut guère être freinée par des considérations de conservation.
Les cris d'alarme lancés par de nombreux spécialistes de différents pays devraient quand-même porter à réfléchir sur les conséquences d'une politique indifférenciée. Or,vouloir réaliser celle-ci sans avoir résolu au préalable les innombrables problèmes que posent le déplacement, l'accrochage et la sécurité des oeuvres, demeure téméraire. C'est dans cette optique que le responsable de la sauvegarde des oeuvres d'art doit prendre conscience des dangers auxquels sont exposées celles-ci, et remédier aux carences afin de réduire, au départ, les risques de dommage.

Notes.

(1) Voir sur ce sujet les importants travaux entrepris par N.Stolow et A.Althöfer.

(2) Il s'agit ici d'un verre dont la surface est traitée comme les lentilles d'un objectif photographique, et non du "verre mat" dont la surface est finement sablée.

(3) Signalons d'une part la rareté des cas où un personnel spécialisé et responsable peut accompagner les oeuvres en voyage; et d'autre part le manque de préparation, souvent, du personnel qui manipule les caisses.

(4) Voir sur ce sujet les contributions du groupe de travail dirigé par N.Stolow : "Protection des oeuvres d'art pendant le transport".

(5) Même dans le cas où nous sommes assurés que les salles d'exposition du lieu de destination sont équipées d'un conditionnement d'air, une panne ou un mauvais fonctionnement des installations peuvent causer des dégâts.

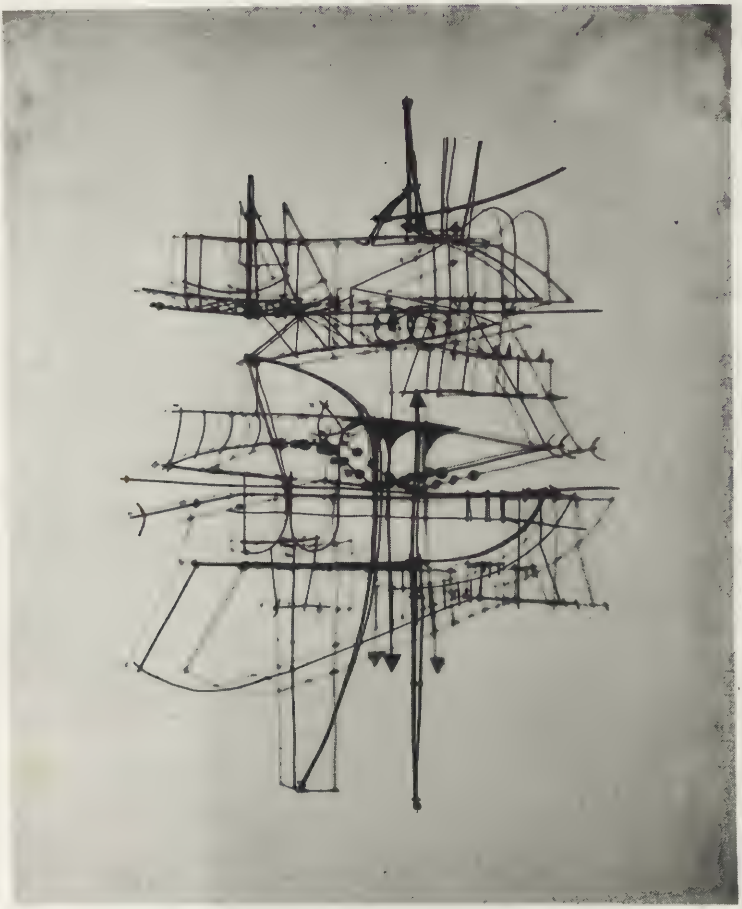
A

<u>Mark Rothko</u>: "Untitled" . 1959

Acrylique sur toile, cm 209 x 125
Détail: angle inférieur droit.

Dégât survenu à un tableau sans cadre: éclatement de la préparation et de la couche picturale aux parties les plus exposées du tableau,à savoir les angles.

Il est indispensable de manipuler les toiles non pour - vues de cadre avec le plus grand soin, en ne les posant que sur un support souple et propre.Lors d'un transport elles devront être munies d'un cadre de protection n'entrant pas en contact avec leur surface, ni avec leurs bords.



B

Walter Bodmer: "Drahtbild 1" . 1937
Relief de fil de fer sur contreplaqué
cm 75 x 60

Dégât survenu à un tableau sans cadre: dépôts de crasse et taches dues au contact des mains; traces claires dues à des essais maladroits d'enlever ces taches.

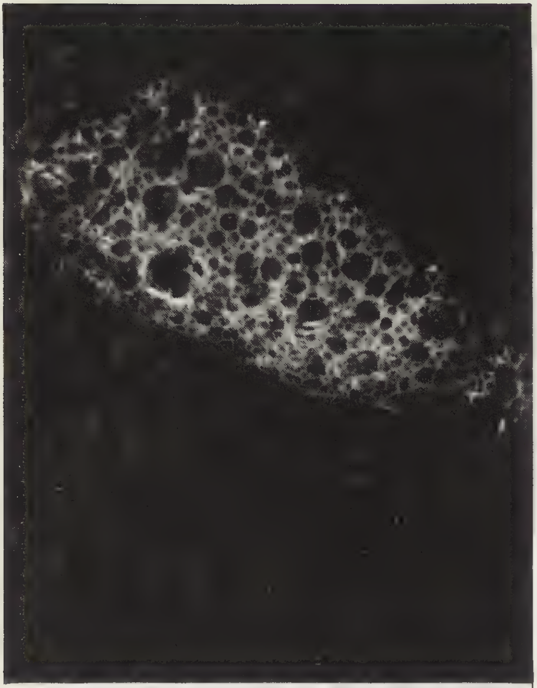
Il est indispensable de porter des guants propres pour manipuler des oeuvres dépourvues de cadre.

C

<u>Barnett Newman</u>: "Day before one". 1951

Huile sur toile. Cm 335 x 127,5
Détail de la partie centrale inférieure,endommagée.

Dégât provoqué par le vandalisme: deux visiteurs ont craché puis étalé leur salive sur le tableau. Celleci a dégradé le vernis spécial mat appliqué par l'artiste.



D

Barnett Newmann: "Day before One". 1951

Huile sur toile
Cm 335 x 127,5
Macrophotographie prise dans la partie supérieure à droite, endommagée.

Dégât provoqué par le vandalisme: une matière moussante et blanchâtre a été giclée sur le tableau.

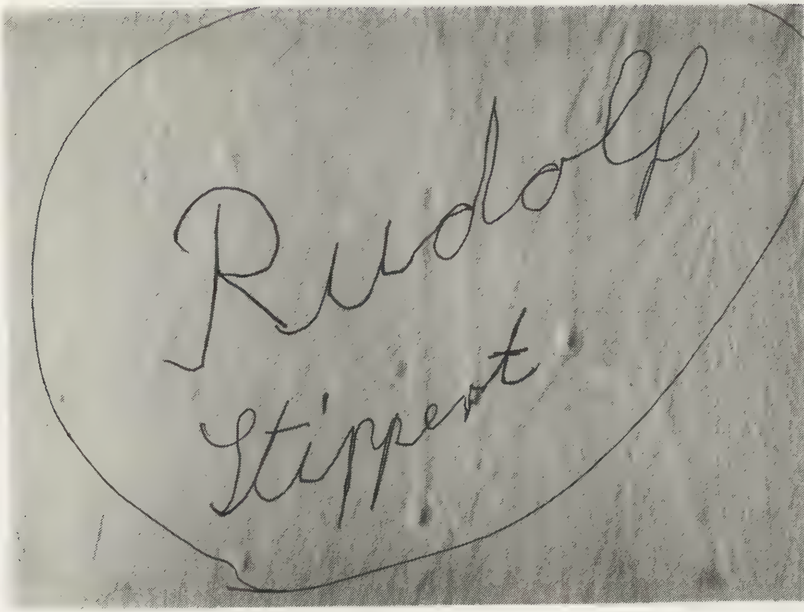
E

Pablo Picasso: "Arlequin assis". 1923

Huile sur toile. Cm 130 x 97
Macrophotographie d'un coup de pinceau à gauche, à la hauteur du coude.

Exemple des reliefs de la couche picturale pouvant être entraînés par les fibres d'un drap ou d'une couverture destiné à "protéger" l'oeuvre d'art.

Un tableau ne doit être emballé que dans un matériau lisse.Celui-ci ne doit pas entrer en contact avec la surface peinte de l'oeuvre -en général on peut tendre la feuille d'emballage par dessus le cadre,si celui-ci existe et est suffisamment saillant par rapport à la surface de l'oeuvre, sinon le tableau doit être pourvu d'un cadre provisoire surélevé.



F

Cy Twombly: "The Veil of Orpheus". 1968 (Quadriptique)

4 panneaux de cm 200 x 122 chacun.
Dispersion et colle sur toile
Détail de la partie médiane,endommagée,
du 4ème volet.

Dégât provoqué de "bonne foi" par un enfant qui s'est inscrit sur le panneau, ne l'ayant pas reconnu comme oeuvre d'art.

G

Robert Delaunay: "Hommage à Blériot". 1914

Peinture à la colle sur toile
Cm 250 x 251
Macrophotographie prise dans la partie centrale, endommagée.

Dégât survenu au cours du transport de l'oeuvre et provoqué par un brusque changement de climat lors de son arrivée à destination (choc climatique): le tableau, qui avait séjourné pendant des années dans un climat stabilisé de 60% d'humidité relative, a été brusquement exposé à une ambiance d'un degré inférieur à 30% d'humidité relative. Une partie de l'humidité contenue dans les fibres de la toile s'est évaporée, et a transporté avec elle des particules de colle qui se sont déposées à la surface du tableau, provoquant les efflorescences visibles dans la partie droite de la photographie.

Une panne ou un mauvais fonctionnement des installations climatiques peuvent provoquer des dégâts graves. Dans ce cas, le tableau avait été entreposé avant d'être accroché dans un local où l'humidité relative était descendue à plusieurs reprises au-dessous de 30%.

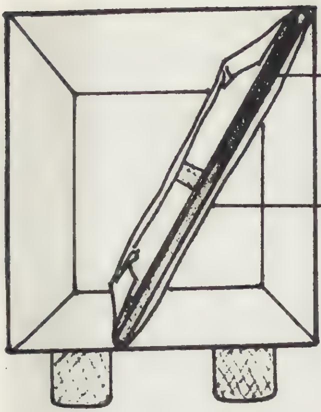


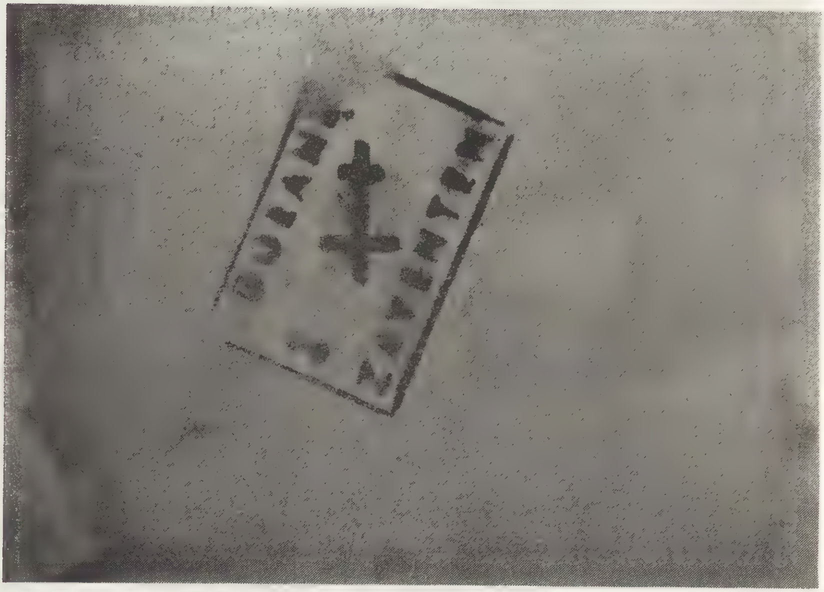
Tableau appuyé contre la paroi d'un camion, toile peinte vers le bas.

Feuille de matière plastique protégeant la surface peinte de l'oeuvre, mais non l'envers.

H

Un grand tableau de J.Olitsky: "First heat", (Acrylique sur toile, cm 225 x 404), avait été endommagé au cours d'un transport par des giclures de cambouis sur l'arrière qui n'avait pas été protégé par un emballage. Le liquide, traversant la toile et la couche picturale mate et claire, avait gravement endommagé l'oeuvre.

La porosité de la toile moderne, lorsqu'elle est combinée avec une peinture mate et claire, est un facteur de fragilité extrême de l'oeuvre d'art contemporain.
Les méthodes usuelles d'emballage des oeuvres d'art doivent être remises en question et modifiées pour pallier à la fragilité des oeuvres d'art contemporain.



K

Hans Arp: "Les trois canes". 1943

Huile sur bois découpé
Cm 114 x 145
Détail de la partie endommagée

Dégât causé par l'excès de zèle ou l'ignorance: un fonctionnaire des douanes a marqué la surface peinte du relief avec son timbre.

LA PEINTURE MATE: DEFINITION. TECHNIQUES PERMETTANT D'OBTENIR L'EFFET MAT: MATERIAUX, MODES D'APPPLICATION, VERNIS MATS.

P. Cadorin et M. Veillon

Le terme "peinture mate" désigne couramment une peinture opaque, non brillante, c'est-à-dire sans variation de luminance à l'observation.

Une peinture est mate lorsque sa surface présente des aspérités suffisamment rapprochées et profondes pour diffuser la lumière

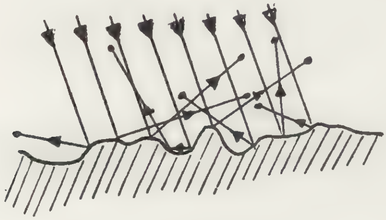


Fig.1 Réflexion diffuse de la lumière. Elle se vérifie quand une surface a des irrégularités plus grandes que les dimensions des corpuscules. (de "Physics", Educational Service Inc. D.C.Heath & Co, Boston 1960).

Cette lumière diffuse est perçue sous la forme d'une plus grande luminosité, et d'une moindre précision des détails.

En termes plus simples, la peinture apparaît plus claire et plus floue.

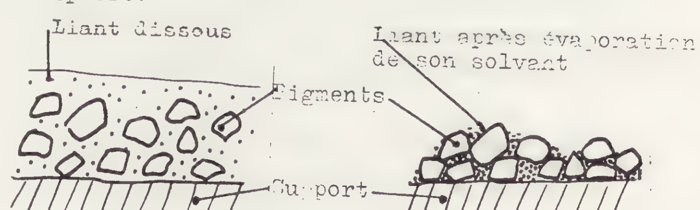
Les techniques susceptibles de provoquer l'effet mat ont toutes en commun une certaine granulosité de la surface.

Celle-ci peut être atteinte par la simple adhérence mécanique des pigments à un support rugueux; c'est le cas du <u>pastel</u>

On l'obtient également en projetant des goutelettes d'une matière liquide qui commence déjà son processus de durcissement pendant sa course vers le support; elle s'y fixe alors dans sa forme de goutte, ce qui donne la structure rugueuse de certaines peintures exécutées au <u>pistolet à air comprimé</u>

Cependant, la technique utilisée le plus couramment pour obtenir cette granulosité de la surface est la technique où deux éléments peuvent se présenter, ensemble ou séparément:

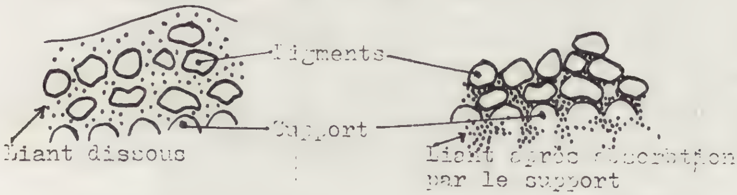
A) l'évaporation d'une partie du liant dans l'atmosphère.



Au moment de l'application de la couche picturale.

Après l'application de la couche picturale: le solvant du liant s'est évaporé dans l'athmosphère.

B.) L'absorbtion d'une partie du liant par le support, ou par la préparation.



Le degré de matité d'une peinture dépend donc non seulement de la composition du liant, mais aussi de la nature du support.

Si le support est poreux, une partie plus ou moins importante du liant sera entraîné par capillarité dans ce support. D'où un déplacement de la masse liquide vers le support qui laissera à découvert plus ou moins complètement les grains de matière solide de la couche superficielle.

Procédant en sens inverse, l'évaporation d'une partie du liant aura un résultat analogue, car le liant, appauvri d'une partie de sa masse se rétrécira, laissant apparaître, comme dans une mare en train de sécher, les aspérités des grains des pigments.

N'oublions pas que le support peut jouer à lui seul un rôle déterminant dans la matité grâce à sa structure rugueuse lorsque la couche picturale est pratiquement absorbée dans son épaisseur (le <u>papier</u> dans le cas de l'aquarelle, le <u>mortier</u> dans le cas de la fresque). C'est alors la structure du support qui formera l'élément réfléchissant la lumière. Quand il s'agira donc d'un papier rugueux, ou d'une toile à surface accidentée, ou d'un mortier contenant des grains de sable d'une certaine grossièreté *, nous aurons au départ l'élément déterminant la matité.

Les techniques de peinture murale comme le "<u>buon fresco</u>", le "<u>fresco secco</u>", le "<u>temperone</u>" etc... ont en commun les trois éléments provoquant la matité. Cependant le degré de matité dépendra non seulement de la grosseur du grain du mortier, mais aussi de l'emploi d'un liant plus ou moins maigre. En effet la consistance onctueuse de la chaux du "bianco san Giovanni" peut conférer au "buon fresco" un reflet soyeux.

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* Andrea Mantegna a employé dans ses fresques une mince couche finale de mortier à la poudre de marbre qui confère un grand poli à la surface. Il s'agit là d'une exception.

Comme l'écrit Hermann Kühn dans son livre sur la conservation des oeuvres d'art*, les liants aqueux, comme les gommes végétales et le blanc d'oeuf, donnent lieu à une peinture mate. Nous ajouterons que tout liant aqueux dans lequel la partie collante est suffisamment diluée peut entraîner un effet mat dû à la moindre cohésion entre les particules solides, et à l'évaporation de l'eau qui laisse beaucoup d'espaces libres entre ces particules.

Il est évident qu'il y aura une quantité de degrés de matité selon l'espèce de liant employé et selon sa concentration dans son solvant qui est l'eau. (Ex.: l'aquarelle, la gouache, les peintures à la colle animale, les peintures à la colle d'amidon, à la caséine etc...)

Même dans le cas où des parties grasses sont émulsionnées dans le liant (lorsqu'elles se trouvent finement divisées et suspendues dans le milieu aqueux qui les maintient dans cette position grâce à sa tension superficielle: tempera), on obtient une surface mate. En effet, les particules émulsionnées de l'huile n'ont pas la possibilité de remonter à la surface pour former un film brillant, mais elles restent sur place. Autour d'elles l'eau, en s'évaporant, laissera des cavités, créant ainsi un effet mat spécifique des peintures à émulsion: tempera maigre, dispersions de résines synthétiques.

Un phénomène analogue peut se produire lorsque des solvants volatils comme l'essence de térébenthine, l'essence de pétrole, la benzine, etc. sont utilisés en certaines proportions avec un liant gras (huile, résine,etc)

Remarquons que, comme le dit justement Marc Havel dans son livre sur "La Technique du Tableau" **, l'effet mat "ne vient pas de la matière même, mais de l'état de sa surface". Ainsi:"le simple frottement... peut... mater s'il crée une multitude d'infimes rayures. C'est ce qu'opère parfois sur certains vernis, le passage léger mais répété du doigt. Un vernis sera mat s'il ne forme pas, en séchant, une surface plane. C'est le cas lorsqu'il comporte certains éléments insolubles, soit dès sa constitution (cas d'une poudre minérale), soit après évaporation du solvant (cas de la cire)."**
Ajoutons qu'il existe d'autres vernis qui, sans adjonction de particules insolubles, produisent le même effet parcequ'ils se "rident" à la surface en séchant.

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* Hermann Kühn: "Erhaltung und Pflege von Kunstwerken und Antiquitäten". (München 1974).

** Marc Havel: "La Technique du Tableau". (Paris, Dessain et Tolra 1974). P.85.

NOTES SUR LA TECHNIQUE EMPLOYEE PAR JOAN MIRO, ET PREMIER EXAMEN D'UNE COLLECTION DE PIGMENTS DU DEBUT DE CE SIECLE RETROUVEE RECEMMENT EN ESPAGNE

E. Porta

RESUME

Enquête sur la technique de Joan Mirò.

Examen d'une collection de pigments trouvés chez un marchand de couleurs à Barcelone. La collection date du début du siècle.

Dans le cadre des enquêtes du groupe "Art du XXème siècle" sur les techniques mises en oeuvre par les peintres de cette période, s'inscrivent en premier lieu tous les renseignements puisés directement chez les artistes encore vivants.

L'oeuvre de Joan Mirò, peintre catalan né en 1893, couvre l'ampleur du XXème siècle de ses débuts à nos jours. Nous avons pu nous entretenir avec lui et de ces conversations nous avons tiré des informations particulièrement intéressantes. Néanmoins, un examen plus approfondi des techniques qu'il a mises en oeuvre est en cours.

Préparations

Renseignements de l'artiste obtenus sur ses différents types de préparations:

- Mirò achetait en général des toiles préparées, mais n'aimant pas leur dureté,il enduisait parfois des toiles brutes de plâtre (Ca SO_4).
- Il a quelque fois peint sur l'envers de la toile préparée, au lieu de le faire sur la couche de préparation.
- Pour obtenir un blanc plus éclatant,il enduisait aussi ses toiles avec du blanc d'Espagne (Ca CO_3) lié à la colle de lapin.
- Il a préféré dans certains cas appliquer une couche de tempera à l'oeuf,en prenant soin d' "ajouter du vinaigre afin d'éviter les attaques biologiques". (sic)

Lorsqu'il a travaillé sur des supports de cuivre, l'artiste a adopté une technique curieuse qui consistait à appliquer un frottis d'ail avant de réaliser toute opération.Cette technique est fort ancienne: Turquet de Mayerne explique et recommande cette pratique pour empêcher l'agression du cuivre par la couche picturale, ce qui interdit la formation de sels verts, altérations superficielle typique de ce métal. Ce phénomène est dû à un principe actif de l'ail appelé Allicine, dont la molécule contient un pont de sulfure -S-S-, lequel réagit avec le cuivre, noir et insoluble, qui protégera le support des attaques postérieures. Cette réaction est facilitée par le PH du milieu.

Liants

Les liants utilisés par Joan Mirò sont ceux qu'emploient presque tous les artistes actuels: l'huile, la tempera et l'acrylique.Il utilise aussi le "Case-Arti" (caséate),qui donne une peinture dure et une surface lisse.

Nous venons d'entreprendre l'étude d'une collection de 167 pigments datée au début du XXème siècle, provenant d'un fond qui a appartenu à un marchand de couleurs.

La révolution industrielle, qui commence en Espagne à la fin du XIXème siècle touche également le domaine des matériaux et des techniques de la peinture. Ce changement permet désormais aux artistes d'acheter leurs matériaux dans des magasins spécialisés qui commencent à s'ouvrir un peu partout. Ces matériaux (pigments, huiles, vernis, toiles, matériaux de charge) proviennent pour la plupart d'importations, car il n'existait pas d'usine qui fabriquait ces produits jusqu'à la première moitié du XXème siècle. Nous pensons évidemment aux matériaux qui portent une marque de fabrique, car depuis fort longtemps le pays produisait une grande variété de pigments vendus communément dans le commerce.

De nouvelles conceptions artistiques ont pu être réalisées grâce à la considérable évolution technique engendrée par ces nouveaux matériaux.

La première apparition en Espagne de couleurs à l'huile produites industriellement daterait des anées 1870. On les trouve dans l'oeuvre de Mariano Fortuny (mort en 1874) dans la gamme suivante: carmin, noir d'ivoire, blanc de zinc, outremer artificiel, etc. Ces couleurs étaient conditionnées dans des tubes de plomb.

Mais le plus grand trésor de matériaux picturaux datant du début du XXème siècle consiste sans doute en une collection que nous possédons et qui parvint jusqu'à nous par hasard. Cette collection comprend 167 petites enveloppes contenant chacune une quinzaine de grammes de pigment en poudre qui ont appartenu à un marchand de couleur dans les années 1900. Cette date a pu être avancée grâce à une coupure de presse utilisée pour remplacer une enveloppe (Actions du port de Barcelone, 1912).

Ces pigments étaient fabriqués par les Fils de Monsieur Haguenauer Aîné, Rue Meissonier 38 et 40, Pantin (près de Paris). Toutes les enveloppes portent la composition des pigments ou leurs noms commerciaux. Beaucoup d'entre elles indiquent également le prix du pigment par kilogramme: 1 ou 2 pesetas pour la plupart...ce qui corrobore la datation supposée pour la collection. Fait remarquable: sur certaines enveloppes, des étiquettes précisent la technique conseillée pour l'emploi du pigment (chaux, huile, colle)

Aperçu de l'ensemble des pigments de la collection

Noirs: charbon, ivoire, velours

Blancs:Z, Herminia, etc.

Bleus: Outremers, Eurêka, de Paris, de Nuremberg, extra, clair, foncé, omnibus, de Prusse, charron, (21 types différents).

Jaunes:de chrome,(du clair à l'orangé) , de Naples, Mondoré.

Verts: de Chine, de Nuit, d'auto, etc. (60 types différents) .

Rouges:de Californie, Eurêka, vermillonette,surfine, d'auto, omnibus, Carminete, Bordeaux, Rubis, etc.

Terres de Sienne et bruns Van Dyck.

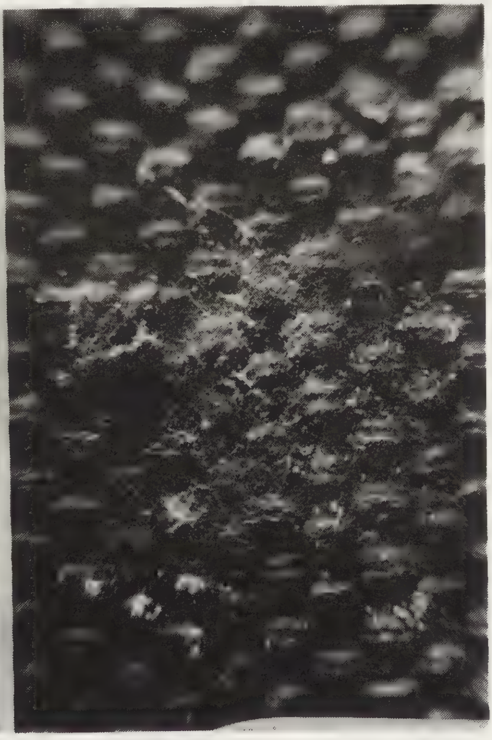
L'importance de cette collection réside dans le grand nombre de pigments répertoriés et dans l'apparition de nouveaux pigments que les peintres espagnols n'avaient jamais utilisés auparavant.

L'analyse chimique de tous les pigments de cette collection est en cours.

L'artiste affirme avoir changé de liant au cours de l'exécution de certaines oeuvres qui,par exemple, furent terminées avec des colles d'origine animale pour obtenir certains tons et qualités désirés.La présence de protéines dans ces colles favorise la croissance de moisissures qui affaiblissent les liants et produisent des taches claires difficiles à enlever.(Voir photographie) Ces taches se forment davantage sur les fonds noirs,particulièrement difficiles à obtenir,et que Mirò retouche le plus.Par contraste optique,c'est également sur cette couleur que les taches de moisissure seront le plus visible.

A cause de l'utilisation de techniques mixtes beaucoup d'oeuvres de Mirò sont délicates et doivent être soumises à un régime climatique très stable.

Nous précisons enfin que l'artiste a exprimé le désir que ses tableaux ne soient pas vernis,considérant qu'un vernissage en changerait la nature.



RESTAURATION D'UNE TOILE DE LUCIO FONTANA ENDOMMAGEE PAR UNE LACERATION

S. Bjarnhof

Dans le cadre de l'enquête sur les déchirures dans les toiles de la peinture contemporaine, nous présentons une oeuvre de Lucio Fontana: "Concetto spaziale". 1967. ('Buchi' dans acrylique bleu sur toile, cm 106 x 118).

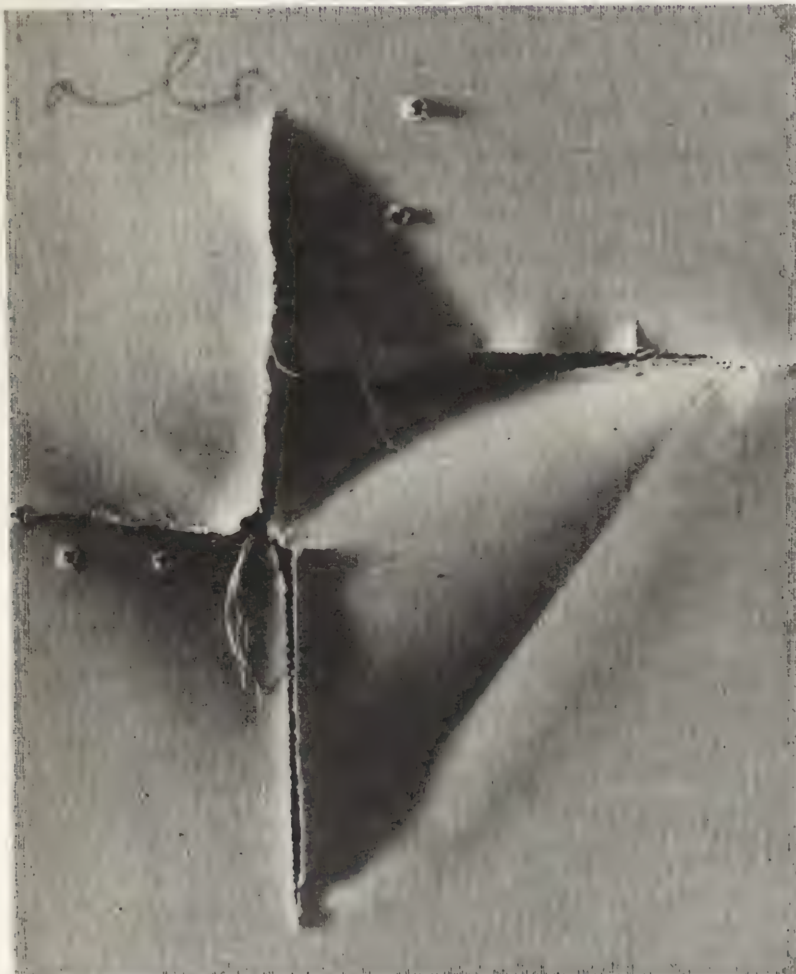
Cette toile a été endommagée dans la zone des trous par une grande déchirure étoilée, avec déformation et pliures dans la toile et lacunes dans la couche picturale.

L'oeuvre de Fontana se trouvait encore en traitement à Copenhague lors de la mise sous presse des 'preprints' pour la 5e réunion triennale du Comité pour la conservation de l'ICOM à Zagreb.

Nous présentons ici les documents du dommage avant la restauration. Une contribution orale illustrée de diapositives fera part au cours de la réunion de Zagreb, des méthodes utilisées pour la restauration de l'oeuvre.

<u>Lucio Fontana</u>: "Concetto spaziale". 1967.
('Buchi' dans acrylique bleu sur toile.
Cm. 106 x 118.)

Vue d'ensemble du tableau avec la déchirure située dans la zone des trous.



Lucio Fontana: "Concetto spaziale". 1967.
('Buchi' dans acrylique bleu sur toile.
Cm. 106 x 118)

Détail de la déchirure vue de l'arrière du tableau.